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With METALLURGICAL SUPPLEMENT.

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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

The Metallurgist.
THE ENGINEER, 25 - 4 - 30.

American Society of Mechanical Engineers: Jubilee Celebrations. (P. 464)
THE ENGINEER, 25 - 4 - 30.

The Naval Limitation Treaty. (P. 463)
THE ENGINEER, 25 - 4 - 30.

The Lochaber Hydro-Electric Undertaking. (P. 456)
THE ENGINEER, 25 - 4 - 30.

The Automatic Stabilisation of Ships No. IV. (P. 450)
THE ENGINEER, 25 - 4 - 30.

International Railway Congress. (P. 466)
THE ENGINEER, 25 - 4 - 30.

Water Power in Canada's Pulp and Paper Industry. (P. 459)
THE ENGINEER, 25 - 4 - 30.

Institution of Naval Architects No. III. (P. 452)
THE ENGINEER, 25 - 4 - 30.

Empire Mining Congress in S. Africa. (P. 455)
THE ENGINEER, 25 - 4 - 30.

INDEX TO ADVERTISEMENTS, PAGE 95.

PUBLIC NOTICES

TO BUILDERS.

The Commissioners of HIS MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 13th May, 1930, for the LOW-PRESSURE HOT WATER HEATING, HOT WATER SERVICES, and FIRE SERVICE at Rampton State Institution.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4886

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
196 TONS MILD STEEL DOGSPIKES.
Tenders due 22nd May, 1930.
Forms of Tender available from the above at a fee of 5s., which will not be returned. 4894

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/2095.—ASSISTANT TOWN PLANNING OFFICER REQUIRED by the LAGOS EXECUTIVE DEVELOPMENT BOARD for two tours of 12 to 18 months' service with possible extension. Salary £480, rising to £720 a year by annual increments of £30 and thence rising to £920 a year by annual increments of £40. Seniority pay of £72 a year on reaching salary of £720 a year. (The question of paying a higher commencing salary than the minimum of the foregoing scale will be considered in the case of the selection of a very highly qualified officer.) Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 24 to 30 years of age, should hold the Diploma of the Town Planning Institute of Great Britain, or such other Degree or Diploma recognised as its equivalent. Must have had good theoretical training in Town Planning at a University or school recognised by the Town Planning Institute of Great Britain. Should have had practical experience in the Preparation of Statutory Municipal Town Planning Schemes and Replanning Schemes for existing areas. Should have a knowledge of the Law in relation to Town Planning practice.

M/1990.—ASSISTANT ENGINEERS REQUIRED for the Public Works Department of the FEDERATED MALAY STATES for four years' service, after which, subject to satisfactory service, the officers appointed will be eligible for confirmation in the permanent and pensionable establishment. It is probable that the number of permanent appointments will be sufficient for those officers whose services have been entirely satisfactory, but no guarantee can be given. If at the end of four years' service an officer's services have been entirely satisfactory and he is not offered or declines further employment, he will be paid a bonus of 2850 dollars. Salary 400 dollars a month, rising to 800 dollars by annual increments of £25 dollars, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No Income Tax at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 23 to 26, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree, or obtain such other Diploma or distinction in Engineering as the Secretary of State may decide in any particular case, or have completed articles with a Civil Engineer of good standing, and have passed sections A and B of the examinations for Associate Membership of the Institution of Civil Engineers. In addition candidates must have had at least one year's practical experience of Civil Engineering under a qualified Civil Engineer.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 4895

Ministry of Transport.
CRINAN CANAL, ARGYLL.

APPLICATIONS are INVITED for an APPOINTMENT as ENGINEERING ASSISTANT in connection with the Reconstruction Work on the Sea Locks of the Crinan Canal for a period of about 18 months. Salary £350 to £400 per annum inclusive, according to qualifications and experience.

Candidates with experience of dock work are required. Preference will be given to men who have served in His Majesty's Forces.

Applications should be made in writing to the ESTABLISHMENT OFFICER, Ministry of Transport, Whitehall-gardens, London, S.W. 1, without delay. 4879

Newry Ship Canal.
TENDERS FOR LOCK GATES

The Joint Committee of Newry Urban District Council and Newry Port and Harbour Trust invite TENDERS from competent Engineering Contractors for INSTALLING ONE PAIR of STEEL OUTER LOCK GATES at Victoria Lock, near Newry, Northern Ireland, to replace the existing timber gates, which are to be removed.

Copies of the drawings, specification and conditions of contract may be obtained at the Offices of the Consulting Engineers, Messrs. R. Ferguson and S. McIlveen, 36, Scottish Provident Buildings, Belfast, on payment of a deposit of Five Guineas, which will be returned on the receipt of a bona fide Tender. No Tender shall be retracted or withdrawn during two calendar months from date in which it is received.

Tenders, sealed and endorsed "Tender for Lock Gates," will be received by the undersigned up to 12 o'clock Noon on Thursday, 22nd May, 1930.

The acceptance of a Tender will be subject to the approval of the Ministries of Finance and Commerce for Northern Ireland.

The lowest or any Tender may not necessarily be accepted. Firms tendering must be responsible for all expenses incurred incidental to the preparation of their Tenders.

W. M. CRONIN (Town Clerk),
Hon. Secretary to the Joint Committee.
Town Clerk's Offices,
Town Hall, Newry. 4897

PUBLIC NOTICES

Borough of Gosport.
REPAIRS TO LANDING STAGE, &c.

The Gosport Corporation are prepared to receive TENDERS for REPAIRING the FLOATING LANDING STAGE and the BROW connecting it with the shore and other contingent works.

The contract drawings and specification may be seen at the offices of the Engineers, Sir John Wolfe Barry and Partners, Dartmouth House, 2, Queen Anne's-gate, Westminster, S.W. 1, on and after Wednesday, the 23rd April, between the hours of Eleven and Four, and copies of the drawings and specification, together with a schedule of quantities and form of Tender, may be obtained there upon payment of Five Guineas. This sum will be repaid by the Corporation upon receipt of a bona fide Tender, accompanied by the specification and drawings, which are to be returned with the Tender.

Tenders, endorsed "Tender for Repairs to Landing Stage, &c.," must be delivered under seal at the office of the Town Clerk, Gosport, Hants, on or before Noon on Saturday, 17th May.

The lowest Tender will not necessarily be accepted.

H. R. MANGNALL,
Town Clerk.
Town Hall, Gosport,
15th April, 1930. 4856

Littlehampton Urban District COUNCIL.

The above Council invite TENDERS for the PROVISION and FIXING of approximately 950 FEET, LINEAL, of IRON RAILING on the East Bank of the River Arun at the mouth of Littlehampton Harbour.

Standards are to be 8ft. apart and fixed in the existing 2in. sockets, with three rows of galvanised tubular or other approved rails, the height of the top rail to be 3ft. 6in. above the existing concrete coping.

A design of the railings must be submitted and the contractor must state date of delivery.

Tenders, endorsed "Tender for Railings," must be addressed to the undersigned and delivered not later than Wednesday, 7th May, 1930.

The Council do not bind themselves to accept the lowest or any Tender.

L. B. BERESFORD,
Clerk to the Council.
Town Offices, Littlehampton,
19th April, 1930. 4874

PUBLIC NOTICES

County Borough of Halifax.
HALIFAX CORPORATION WATERWORKS.
WARLEY MOOR RESERVOIR.

The Waterworks Committee are prepared to receive TENDERS for the RECONDITIONING of WARLEY MOOR or "FLY FLAT" RESERVOIR, situate at the head of Luddenden Brook, about 6¼ miles from Halifax. The work will consist of the Construction of an Embankment across the Northern End of the Reservoir, the Removal of Peat from the Bottom of the Reservoir, and its Disposal behind the said Embankment; the Lining of an existing Catchwater; and the Construction of an Entrance Road, &c.

Drawings may be seen and copies of the specification, schedule and form of Tender obtained on application to Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon the receipt of a cheque for Five Guineas. This sum will, after the Corporation shall have come to a decision upon the Tenders, be returned to those parties who shall have sent in a bona fide Tender, shall not have withdrawn the same, and shall have returned the documents and drawings lent to them for the purpose of making up their Tender. A limited number of sets of drawings (uncoloured) are available and will be lent to persons tendering in priority of application on receipt of the sum of Two Guineas, which will not be returned.

Sealed Tenders, endorsed "Halifax Corporation Waterworks. Warley Moor Reservoir," must be forwarded to the Town Clerk, Town Hall, Halifax, on or before Friday, the 16th May, 1930.

The Committee do not bind themselves to accept the lowest or any Tender.

PERCY SAUNDERS,
Town Clerk.
Town Hall, Halifax,
12th April, 1930 4851

Argyll County Council.

APPLICATIONS are INVITED for the POST of COUNTY ENGINEER and SURVEYOR for the County of Argyll, which will be open to members or associate members of the Institution of Civil Engineers or members of the Institution of Municipal and County Engineers. Salary £700 per annum, rising by annual increments of £50 to £900.

Conditions of appointment may be obtained on application to the COUNTY CLERK, Lochgilphead, with whom twelve copies of applications, accompanied by twelve copies of recent testimonials, should be lodged not later than 10th May proximo. 4876

PUBLIC NOTICES

Administrative County of LONDON.
VICTORIA EMBANKMENT CONVENIENCES.

The London County Council invites TENDERS for the EXTENSION and ALTERATION of the PUBLIC CONVENIENCES on the Victoria Embankment near Westminster Bridge.

The specification, bills of quantities, drawings and form of Tender may be obtained on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W.1, upon payment of £1 by cheque, draft, or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 9A, No. 8, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 19th May, 1930, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
4864 Clerk of the London County Council.

South Indian Railway Com- PANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—
MADRAS IMPROVEMENTS.
ELECTRIFICATION OF SUBURBAN SERVICES—TRACK BONDS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked :—"Tender for Track Bonds," with the name of the firm tendering, must be left with the undersigned not later than 12 Noon on Friday, the 9th May, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

Copies of drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France,
Westminster, S.W. 1.
23rd April, 1930. 4892

ENGINEERING AND MACHINE TOOL MAKING BUSINESS FOR SALE BY PRIVATE BARGAIN.

The Subscribers are Prepared to receive OFFERS as a GOING CONCERN for the OLD-ESTABLISHED BUSINESS (including Goodwill, Ground, Buildings, Plant, Machinery, Drawings, Patterns, Patents, Stock, &c.) belonging to CLIFTON and WADDELL, LAIGHCARTSIDE WORKS, JOHNSTONE.

The Works, which are situated conveniently to the L.M.S. Railway Sidings, cover an area of approximately 3600 square yards. They include Machine, Erecting, and Pattern Shops, Stores and Offices.

The firm is engaged in the manufacture of Metal Sawing and Allied Machinery and has been established for 32 years, having a valuable connection amongst Structural and General Engineers, Steel Works, Shipyards, &c.

Intending purchasers may view the works, machinery and plant by arrangement with the Subscribers, who will furnish full particulars.

THOMSON McLINTOCK & CO.,
Chartered Accountants.
216, West George-street, Glasgow,
14th April, 1930. 4854

Amersham, Beaconsfield and DISTRICT WATERWORKS COMPANY.
SECRETARY AND MANAGER.

The Directors of the above Company invite APPLICATIONS for the POSITION of SECRETARY and MANAGER from those having practical experience in Waterworks Management. Salary £750 per annum.

Further particulars may be obtained from the undersigned, to whom applications, marked "Secretary and Manager," stating age, experience, date upon which duties can be commenced, and enclosing copies of three recent testimonials (which will not be returned), should be sent not later than Monday, the 19th May next.

ROFE & RAFFETY,
Consulting Engineers to the Company.
208, Abbey House,
Victoria-street, S.W. 1. 4867

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
AUCTIONS, Page 96.
PARTNERSHIPS, Page 2.
MISCELLANEOUS, Page 2.
BUSINESSES and PREMISES (For Sale, etc.), Page 96.
EDUCATIONAL, Page 2.
MACHINERY, &c., WANTED, Page 2.
PATENTS, Page 2.
FOR SALE, Pages 2, 4 and 96.
AGENCIES, Page 2.
WORK WANTED, Page 96.
FOR HIRE, Page 2.

For Advertisement Rates see Leader Page.

PUBLIC NOTICES

British Non-Ferrous Metals
RESEARCH ASSOCIATION.

APPLICATIONS are INVITED for the POST of DEVELOPMENT OFFICER from Engineers or Metallurgists of personality, energy and tact, with sound scientific training and works experience in the manufacture and application of Non-ferrous Metals and Alloys.

The duties will consist in supplementing, developing and demonstrating the results of research in the Association's Laboratories and in the works of its members; and in helping and encouraging members in the application of these improvements of processes and products.

The work is partly extra-mural, but the Association is intending shortly to establish enlarged headquarters in London.

A salary up to £800 p.a. will be paid according to qualifications and experience.

Applications, confidential if desired, should be sent with full particulars of training and experience to the DIRECTOR, B.N.F.M.R.A., 71, Temple-row, Birmingham. 4865

British Non-Ferrous Metals
RESEARCH ASSOCIATION.

APPLICATIONS are INVITED for a new POST of RESEARCH MANAGER, who will serve immediately under the Director of the Association, and undertake the general organisation, supervision and co-ordination of both extra-mural and internal researches.

This work will include management of the Association's Research Laboratory, which it is intended shortly to establish in London as part of a new headquarters' scheme.

Experience of research and research methods, as applied to metals, is necessary, but the duties demand in addition energy, organising ability and a sympathetic understanding both of the scientific workers and of the industrial clientele which the Association aims to serve.

Some acquaintance with the drafting of research reports, so as to bring them forward in a clear form and to stress their possible industrial applications, is particularly desirable.

A salary up to £1000 p.a. is offered to a man of suitable qualifications.

Applications, confidential if desired, with full particulars of training and experience, should be addressed to the DIRECTOR, B.N.F.M.R.A., 71, Temple-row, Birmingham. 4865*

City of Nottingham.
APPOINTMENT OF CHIEF ENGINEER AND GENERAL MANAGER, ELECTRICITY SUPPLY DEPARTMENT.

The Nottingham City Council invite APPLICATIONS from qualified Electrical Engineers for the POSITION of CHIEF ENGINEER and MANAGER of their undertaking.

The person appointed will be responsible to the Electricity Committee and the City Council for the control and management of the undertaking, and he will be required to devote his whole time to the duties of the office, and will not be allowed to engage, either directly or indirectly, in private work of any kind. He will be expected to have, in addition to high technical qualifications, a considerable capacity for business and to show proof of an enterprising disposition.

The appointment will be subject to the provisions of the Local Government and Other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination.

The salary will be £1750 per annum, subject to the scale of remuneration adopted from time to time by the Standing Joint Committee of the Incorporated Municipal Electrical Association and the Chief Engineers' Association.

Applications, accompanied by copies of three recent testimonials, must be delivered to me in a sealed envelope, endorsed "Chief Engineer, Electricity Department," not later than the 12th May, 1930. An applicant may, if he so desires, forward to me not more than 20 copies of his application and testimonials for the use of the Members of the Committee.

Canvassing Members of the Council, either directly or indirectly, is prohibited, and will be a disqualification.

W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
16th April, 1930. 4875

Harris Institute, Preston.

The Council of the Harris Institute invite APPLICATIONS for the POST of FULL-TIME ASSISTANT TEACHER in the Engineering Department and Junior Technical School. The appointment will date from September 1st, 1930.

Salary in accordance with the Burnham Scale for Technical Teachers.

Form of application may be obtained from the undersigned, to whom the completed form, together with copies of testimonials, should be returned not later than May 2nd, 1930.

E. C. MOYLE,
P6919 Principal and Secretary.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, by Manchester Engineering Firm, an ASSISTANT for their London Office. Public School Boy required, about 20/25, with General Engineering Training and preferably practical Electric experience. State age, experience and salary.—Address, 4866, The Engineer Office. 4866 A

APPLICATIONS for POSITIONS as JUNIOR ENGINEERS are invited from men with B.Sc. Degree or equivalent standard, and some Works Experience in either Electrical, Mechanical, or Chemical Engineering. Letters must give information under the following heads and in the order stated:—(1) Name and age; (2) education, training and examinations passed; (3) full details of experience; (4) salary required.—Write, in confidence, 4889, The Engineer Office. 4889 A

ASSISTANT to WORKS MANAGER REQUIRED for old-established Factory (not Engineering), North London. Age 25-30; must have practical Workshop and Works Manager's Office experience and able to control male and female labour. State age, experience and salary required.
Address, P6934, The Engineer Office. P6934 A

CIVIL ENGINEER REQUIRED by English Drainage Company in South America. A capable and experienced Engineer, preferably between 26 and 30 years of age, and a knowledge of Spanish, French or Portuguese an advantage. Only an Engineer with good experience of Sewerage Work in a large city will be accepted.—Write in first instance, giving full particulars of age, experience, qualifications, &c., to S., c/o Davies and Co., 95, Bishopsgate, London, E.C. 2. 4869 A

REQUIRED, ACCOUNTANT to Undertake Audit and Monthly Balance for Small General Engineering Works in London Area. Turnover about £25,000 per annum.
Must have similar experience.
State terms and full particulars in confidence.
Address, P6923, The Engineer Office. P6923 A

SALESMAN REQUIRED with Connection to Sell Contractors' Plant and Equipment. Applicants should state age, experience and salary required.—Address, 4896, The Engineer Office. 4896 A

WORKS MANAGER REQUIRED for Large and important Works in London Area producing highest class Heavy Non-ferrous Castings. Applicant must have held responsible position and have outstanding organising and administrative ability and experience in Foundry and Heavy Machine-shop practice.—Address, stating qualifications, experience, age, salary required, 4893, The Engineer Office. 4893 A

LEASE OF IMPOSING OFFICES FOR SALE.
33, NORFOLK STREET, STRAND, W.C. 2.

In consequence of the recent amalgamation of "The Engineer" Ltd., proprietors of "The Engineer," with Morgan Bros. (Publishers) Ltd., proprietors of "The Ironmonger" and "The Chemist & Druggist," the offices of the three journals will shortly be transferred to new and more commodious freehold premises which have been acquired at 28-31, Essex Street, Strand, W.C. 2.

The remainder of the lease, covering a further twenty-five years, of the present offices of "The Engineer" at 33, Norfolk Street, Strand, W.C. 2, is in consequence for sale. This particularly well lighted five-storey building has an area of 8,200 sq. ft., and occupies a site at the corner of Norfolk and Howard Streets, adjacent to the Temple Station, whence Westminster and the City may be reached in a few minutes. The building is of modern construction and has a fine and distinctive elevation. It is in good order throughout, and vacant possession can be had in June next. Rent £1,600. Moderate price. For further particulars apply to:—

WHATLEY, HILL & CO.,
24, Ryder Street, St. James', S.W. 1.

SITUATIONS OPEN (continued)

WORLD-WIDE Organisation has VACANCY in London area for successful SALESMEN with Sound Mechanical Engineering Knowledge. Own car essential. Good prospects for active educated men. Send full particulars, which will be considered confidential. —Address, 4878, The Engineer Office. 4878 A

CHIEF DRAUGHTSMAN WANTED by London Engineering Company. Salary £800. Reply stating fully technical qualifications and experience. Must be good organiser of staff.—Address, P6925, The Engineer Office. P6925 A

DRAUGHTSMAN REQUIRED, Age 25-30. Experience in Light Truck Design desirable, but not essential.—State age, experience and salary required, to THE SKEFKO BALL BEARING CO., Ltd., Luton. 4871 A

DRAUGHTSMEN (TWO) REQUIRED, Temporary, in the provinces; Structural Steelwork, Buildings, &c.—Address, stating age, experience, and salary required, 4887, The Engineer Office. 4887 A

DRAUGHTSMEN WANTED, Fully Experienced Jig and Press Tool Designers. Must have first-class experience of Jigs, Press Tools and Production Equipment for Automobile Work. State age and experience. —Address, 4796, The Engineer Office. 4796 A

JUNIOR DRAUGHTSMAN REQUIRED by a Firm of Constructional Engineers in London.—Address, stating age, experience, and salary required, P6914, The Engineer Office. P6914 A

MECHANICAL DRAUGHTSMAN, Age 28 to 30, Plant Maintenance. Quick, accurate and able to work with slight supervision. Previous experience Rubber Machinery advantage, but not essential.—Address, 4882, The Engineer Office. 4882 A

REQUIRED IMMEDIATELY by Consulting Engineers, London, First-class JUNIOR STRUCTURAL STEEL and BRIDGE DRAUGHTSMAN. Able to work out Stress Diagrams and Calculations; neat worker essential. State experience, age, salary required.—Address, 4890, The Engineer Office. 4890 A

SITUATIONS WANTED

CAPABLE ENGINEER, A.M.I. Mech. E., Good commercial abilities, fluent Spanish, French, Italian, SEEKS POSITION with good firm. Good references.—Address, P6932, The Engineer Office. P6932 B

COMPETENT EXECUTIVE, Experienced in the organisation and establishment of industries and works on production basis, DESIRES advantageous OFFER; exceptional record.—H. W., 40, Lebanon-road, Croydon. P6819 B

ENGINEER, Civil and Constructional, Four Years holding responsible position with engineers and public works contractors, desiring change, SEEKS to ACT as REPRESENTATIVE in London of firm of engineers or allied trades. Can arrange office accommodation in Westminster.
Address, P6936, The Engineer Office. P6936 B

ENGINEER DESIRES CHANGE, at Present Engaged as fitting shop foreman. Marine engine and public works experience, erection and maintenance. Salary £300 p.a.—Address, P6939, The Engineer Office. P6939 B

ELECTRIC ARC WELDING.

ENGINEER REQUIRES POST as SUPERINTENDENT of welding department. 10 years' experience; also 7 years as mechanical engineer. Could include Premier Portable Welding Plant and Mawdsley's Welding Dynamo.
Address, P6938, The Engineer Office. P6938 B

ENGINEER (30) SEEKS CHANGE. Public School education, exp. shops, D.O., assistant engineer, works extensions and maintenance.—B.M./L024, London, W.C. 1. P6887 B

FIRST-CLASS HONS. B.Sc. in Mech. Eng., Age 24, with 5 years' experience in works and D.O., SEEKS SUITABLE POSITION.—Address, P6937, The Engineer Office. P6937 B

MECHANICAL ENGINEER, Certificated, 37, married, who has been engaged past ten years on tea and rubber factory construction and design, also general engineering with large firm in S. India, WISHES IMPROVE POSITION, preferably with work in S. India or abroad. Has previous experience manufacture of mining plant, flying and internal combustion engines. Speaks Tamil. Will be in London middle of May.—Address, B.M./F.K.G, 8, London, W.C. P6926 B

MAINTENANCE ENGINEER or FOREMAN ERECTOR SEEKS POSITION; 40, experienced with locomotives, machine tools, cranes, conveyors; excellent testimonials.—Address, P6929, The Engineer Office. P6929 B

SITUATIONS WANTED (continued)

ENGR., D.O. and Workshop Trained, with over 20 yrs.' varied experience in steam, general, mechanical and chemical engineering, including tar products, plant lay-outs, &c., supervising erection of plant, charge general factory plant, control labour, SEEKS OPENING.—Address, P6930, The Engineer Office. P6930 B

STRUCTURAL ENGINEER (London University), thoroughly trained by leading engineers, DESIRES POSITION that will utilise good qualifications and experience.—Address, P6935, The Engineer Office. P6935 B

TO ELECTRICAL and MECHANICAL ENGINEERS. —Trained engineer having specialised for the past 16 years on scientific purchasing and modern practice in store keeping and accounting with important organisations, DESIRES CHANGE. Keen, energetic and economical worker; thorough knowledge of world's markets. Good organiser and able to control staff and working force so as to obtain best results from team work. Highest credentials.
Address, P6886, The Engineer Office. P6886 B

PARTNERSHIPS

PARTNERSHIPS.—Business Men in Need of Further WORKING CAPITAL and have no objection to a Private Limited Liability Company (sound propositions or Patents entertained), Write or 'Phone Holborn 5048.—RAY and RUSSELL, 88, Chancery-lane, London, W.C. 2. P6931 C

EDUCATIONAL

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INST. OF STRUCTURAL ENGRS.,
UNIVERSITY OF LONDON, &c.,
are personally conducted by
Mr. Trevor W. Phillips,
B.Sc., Honours, Engineering, London University, Assoc. M. Inst. C.E., A.M.I. Struct. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.
For full particulars and advice apply to:—36, Dale-street, Liverpool (Tel., Bank 1118). London Office: 65, Chancery-lane, W.C. 2. EX.

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THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN (*Established* 1917).
76, Temple Bar House, London, E.C. 4.

AGENCIES

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New Naval Construction.

H.M.S. "LEANDER," the only remaining cruiser of the 1929 programme, is about to be laid down at Devonport. The other two ships, it may be remembered, a 10,000-ton and a 6000-ton cruiser, were cancelled recently, in order, it was assumed, to facilitate the disarmament negotiations. There is, however, a strong probability that the 6000-ton ship will be restored, as her early construction is necessary if the British quota of 6in. gun cruisers is to be reached by 1936. Although no official details are available, the "Leander" is believed to be designed for very high speed and an armament of eight 6in. guns, mounted in twin turrets along the centre line. Electric welding may be utilised in the building of the hull. She will be the first of a new type, many of which must be built in the next five years. In fighting value she will come between our "D" class cruisers and the American "Omaha" group, but there can, of course, be no comparison between this design and an 8in. gun ship, which is immeasurably superior in military power. The remaining vessels of the programme are to be distributed between the dockyards and private firms. Devonport is to be responsible for the sloop "Bideford," Portsmouth for the destroyers "Crusader" and "Comet," and Chatham for the sloop "Rochester," while the flotilla leader "Kempenfelt" and the destroyers "Cygnet" and "Crescent" will be built by contract. There is a feeling in shipbuilding circles that the Royal yards have been unduly favoured on this occasion, and the hope is expressed that a fairer distribution will be made of such work as is to be undertaken this year, the extent of which has yet to be announced by the Government.

Subsidising Air Transport.

A MEMORANDUM has been issued by the Minister for Air explaining the financial effect of the Air Transport (Subsidy Agreements) Bill. The financial resolution embodied in the Bill authorises the President of the Air Council to agree, subject to the approval of the Treasury, to pay subsidies to any persons and to provide facilities for their aircraft in consideration of those persons maintaining a regular service for the carriage by air of passengers, goods and mails. The money required for this purpose is to be provided by Parliament, and in the aggregate is not to exceed £1,000,000 in any financial year. No subsidy is to be payable after December 31st, 1940, under any agreement entered into under the terms of the Bill. For the financial year 1930 it is estimated that the gross charge for subsidies falling upon the Air Votes will be £428,000. Included in this sum are the subsidies payable to Imperial Airways in connection with the European and England–India air services and the projected African air service. This gross figure will be reduced by £20,000 by contributions from other Governments towards the cost of the African service. For the financial year 1931 the gross estimated sum required for subsidies is given at £550,000, and the net sum at £378,000, on the assumption that the African service will by that time be in full operation. The existing and projected subsidies are, or are to be, arranged on a descending scale, and consequently the limit of £1,000,000 per annum leaves a reasonable margin for any further subsidised services that may be established during the next ten years or so.

An Exhibition of Weights and Measures.

AT the Science Museum, South Kensington, a permanent exhibition has been opened illustrating the history of weights and measures. The exhibits cover a wide range in time. The earliest is an equal armed balance of 1350 B.C. from Egypt. Its beam is of wood and it is suspended by a cord. One of the original stone weights used in conjunction with it is shown. Mr. W. A. Benton, of Messrs. Avery, Birmingham, has supplied a number of models illustrating the improvements made within modern times in the means for measuring large weights with accuracy and speed. Among Mr. Benton's models one of the most interesting is a reconstruction of a design for a self-indicating balance contained in a manuscript by Leonardo da Vinci. This balance consists of a metal semi-circle mounted to turn in a vertical plane about a pivot passing through its circular centre and carrying a fixed weight at one end and a pan at the other. The weight placed in the pan is measured by a scale on the circular edge of the disc against a pointer hanging from its circular centre. An alternative design involving the use of an equilateral triangle instead of a semi-circle was also suggested by Leonardo and is illustrated by another of Mr. Benton's models. Among the balances and steelyards is a small Chinese instrument of ivory, which folds up into a case only half an inch thick, and a huge bullion balance made in 1819 by Vandome for the Royal Mint and capable of reading accurately to a fifth of an ounce. Instruments for the measurement of length are included in the exhibition. Among them are Watt's micrometer, Whitworth's millionth machine of 1855, and recently developed National Physical Laboratory comparators making use of an optical principle. Three standards of length have been lent by the Royal Society, namely, Graham's standard yard of 1742, Bird's standard 90in. of 1750, and Shuckburgh's standard 60in. of 1796. It was with the aid of these standards that the Standards Commission of 1843–55 was enabled to correlate the Elizabethan yard with the standard yard now in use after the destruction of the Imperial standard in the fire at the Houses of Parliament in 1834.

The County of London Electric Supply Company.

ON Wednesday, April 16th, the thirty-sixth ordinary general meeting of the London Electric Supply Company was held in London. In the absence of Sir Harry Renwick, owing to illness, Sir Bernard E. Greenwell presided. Referring to the engineering aspects of the undertaking, Sir Bernard explained that the Barking power station was the pulse of the business, and that the second section of that station had been practically completed, and was running satisfactorily. During the past year the operating efficiency had improved considerably; in fact, the thermal efficiency was now very near to the highest so far obtained in any station in the country. As to the growth of output, the units sent out from the station in 1922 were only 71,500,000, whereas last year they reached the high-water mark of 426,500,000, an output that was probably unequalled by any single or separate station in the country. The progress of the past was, however, nothing compared with the possibilities of the future. During the year a considerable amount of distribution work had been carried out in the company's Essex area, and supplies had been established at a number of points. The additional kilowatts connected by the company last year amounted to the unrivalled figure of over 46,000, and there was an increase of some 40,000 in new consumers. For years past the company had offered to large power and industrial consumers rates for supply which were probably the lowest in the country. As far as the output for domestic purposes was concerned, there had been an increase of 24 per cent. as compared with the preceding year. That was the average over the whole area, but in certain districts the domestic consumption had increased by upwards of 40 per cent.

Improvements on the L.N.E.R.

A COMPREHENSIVE scheme of railway and dock improvements, involving an expenditure of £1,700,000, is to be carried out by the London and North-Eastern Railway Company under the Development (Loan Guarantees and Grants) Act of 1929. The programme of work includes the widening of the main line on the East Coast route on short sections between York and Northallerton, and also near Montrose on the section between Edinburgh and Aberdeen. At Mexborough East Junction new loop lines are to be constructed to assist the handling of heavy goods and coal traffic from South Yorkshire. Important dock improvements are to be made at Hull and Grimsby, which include the provision of further sidings and storage ground at Hull and two new berths, additional sidings, and new cranes at Grimsby. In the London district new goods yards and sidings are to be built at Stratford Temple Mills and Ferme Park, while new sidings, with the object of speeding up sugar beet and goods traffic, are to be provided at Bishop's Stortford. Additional siding accommodation will be arranged at Woodford and Hinton, with the object of expediting the exchange of traffic with the Great Western Railway, *vid* Banbury. Improvements in the Manchester district include the provision of a large new goods station at Ashburys, which will be equipped on the most modern lines and will afford facilities for firms to establish railhead depôts. At Bo'ness in Scotland the sleeper creosoting plant is to be extended and rebuilt on a larger site, while new locomotive depôts are to be built at Frodingham, in Lincolnshire, and at Thornton Junction, on the main line to Aberdeen. The work above outlined is additional to that being carried out under six other schemes for the improvement of the railway, and the dock and coal handling appliances at Hull and Grimsby, to which reference has already been made in our columns.

Finance and the Basic Industries.

FURTHER detailed information is now available concerning the new company which has been recently formed for the purpose of facilitating the rationalisation of our basic industries. It will be recalled that the company, which was referred to by Mr. J. H. Thomas in his Manchester speech, has the support of the Bank of England and most of the influential banking and financial houses in the country. Its registered capital is £6,000,000, which is made up of "A" and "B" shares, the former being subscribed by the banks and financial houses and the latter by the Securities Management Trust, Ltd. The chairman of the company is the Right Hon. Montagu Collet Norman, and Sir Guy Granet, another director, will alternate with Mr. Norman. Other directors include Baron Bruno Schröder, with Major Albert Pam as alternate, and Mr. A. R. Wagg with Mr. Nigel Campbell as alternate, also Mr. E. R. Peacock and Mr. C. Bruce Gardner, the managing director of the Securities Management Trust, Ltd. In addition to the board of directors there will be an advisory council, upon which a number of influential financiers have been invited to serve. The object of the company is to receive and consider schemes submitted by the basic industries of the country for the purpose of their rationalisation either by industries or by regions. Where such schemes find approval the essential funds will be provided through existing agencies. It is understood that the services of the company and its financial facilities are to be placed at the disposal of basic and regional industries and that individual companies and minor industries do not come within the scope of its activities. We gather that it is not intended to call up the whole of the capital of the company, nor will the company be a profit-earning proposition. Its sole desire is to help the basic industries of the country to recover, and we understand that to this end the members of its board have consented to give their services without reward. The business address of the company is 5, Lothbury, London, E.C. 2.

New Liners and the Atlantic Passenger Traffic.

THE recent amalgamation of the Hamburg-American and North German Lloyd shipping interests, and the putting into service of the "Bremen" and "Europa," have revived interest in a possible pooling of British Atlantic shipping interests, with the object of securing more economical service and effecting the construction of new fast liners. The question, it is understood, is one which may be discussed by a conference of the directors of the Cunard and White Star companies, which will take place in London. The returns from the beginning of the present year till April 15th show, compared with the same period last year, a decline of 5000 first-class passengers on the east-bound run and 3000 on the west-bound run. The eastward decline is no doubt attributable to the financial position following the Wall-street collapse and its repercussion in Canada. But in spite of the reduction in passengers carried, there is no interruption in the building programmes of the different nations. In addition to the liners to be laid down by French and Italian shipping companies, there are the ships proposed by the Cunard and White Star lines, and those of the United States Lines. On his recent arrival at Southampton, Mr. Joseph Sheedy, of the United States Lines, said that two 30,000-ton, 20-knot liners would be shortly put in hand for the 1932 season, and that before the end of the present season orders for two liners of slightly under 60,000 tons, with a speed of 28½ knots, would be placed.

The Late Mr. J. A. Wickham.

WE regret to have to record the death this week of Mr. J. A. Wickham, chief engineer for docks, North-Eastern Area, London and North-Eastern Railway. He joined the company in June, 1924, as assistant to the chief general manager, King's Cross, and in 1925 was appointed assistant general manager and industrial agent. In January, 1928, he became chief engineer for docks, North-Eastern Area. Before joining the London and North-Eastern Company he was a partner in the firm of Cowper and Wickham, consulting engineers. In his early days he was responsible for the construction of a number of important public works in this country, Brazil, Chile, and elsewhere. During the war he served in several engineering capacities in France, finally becoming Director-General of Transportation. Subsequently he served on several Government and other commissions abroad, including in 1922 a valuation on behalf of the Government of the military railways and other works in Palestine and Sinai.

Electric Power in the Punjab.

A REPORT on the progress of the Uhl River (Mandi State) hydro-electric scheme has been issued by the Committee of Inquiry appointed by the Government of the Punjab. In view of the expenditure and large commitments already entered into, the Committee does not recommend the abandonment of the scheme; in fact, it is considered that the supply of power to the public should begin not later than July, 1933. It is estimated that the ultimate cost of the scheme will be about £4,688,000, instead of £3,200,000, as originally estimated. The determining factor for both the date of completion and the final cost must, however, necessarily be the progress of the boring of the tunnel through the Himalayan ridge between the Uhl and the Beas, by which the water of the Uhl will be carried for 2½ miles through the mountain and then dropped 1800ft. down the hillside to a power house beside the Beas. It is recommended that before extending the scheme to the second stage, which involves increasing the output from 36,000 to 70,000 kilowatts, an expert committee should be appointed to examine the merits of such an extension as compared with the generation of power from canal falls and heat engine plant. The report states that the current generated will be distributed by a "grid" of lines spread over the foot of the hills to the Jhelum River, in the north of the Punjab, and to Delhi in the south. The scheme will provide many small towns and villages with electric power and will greatly assist a number of mines and factories.

The Automatic Stabilisation of Ships.

No. IV.*

THE first actual vessel to be fitted with Frahm anti-rolling tanks was the Hamburg-American twin-screw cargo and passenger steamer "Ypiranga" running between Hamburg, Mexico, and Buenos Aires. The results achieved were deemed so satisfactory that immediately after the first trial at sea the sister vessel "Corcovado" was similarly equipped.

These two vessels were of recent construction, but although they were fitted with bilge keels 1ft. in depth, over two-thirds of their length, they had acquired a reputation for rolling badly. They had a length of 447ft., an extreme breadth of 55ft., a loaded draught of 25ft. 5in., a loaded displacement of 14,100 tons, and a speed of 13 knots. The tanks, being in the nature of afterthoughts, were not worked into the hull structure, but were built up directly on the main decks. Each vessel was equipped with two entirely separate tank systems, one at about a quarter of the ship's length from the bow and the other at about an equal distance from the stern.

In Fig. 7 we illustrate this early example of the Frahm system in cross section. Each unit consisted of two wing tanks, 9ft. high, 25ft. long, and 10ft. wide, placed on the main deck with their outer walls forming continuations of the ship's sides. A lower, or water, connection, 1ft. 6in. in height and the full 25ft. in width, was laid down on top of the main deck to unite the two tanks. The upper or air connection was provided by means of two trunks fixed beneath a flying bridge, extending from tank top to tank top, and carrying the winches for operating the derricks on the adjacent mast. Curved baffles, as indicated, were provided in the tanks and longitudinal movement of the water in the lower connection was restricted by five rows of flat baffle plates. The tanks

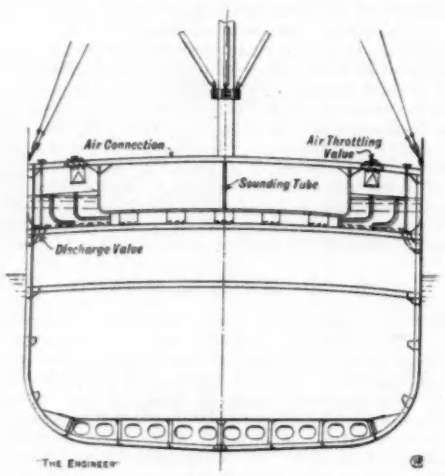


FIG. 7—FRAHM TANKS ON S.S. "YPIRANGA"

could be filled with water by means of the pumps used when the decks were being washed, and could be emptied through a discharge valve on each side.

The dimensions given indicate that the total capacity of each of the two units was about 166 tons, namely, 64 tons in each of the side tanks and 38 tons in the lower connection. The actual weight of water used in each unit was 94 tons, implying that the side tanks were just a little under half full. Roughly, a third of the water may be said to have been in the lower connection and a third in each of the side tanks. The total weight of water in the two units was, it will be seen, 188 tons. The weight of the actual tank structures is not recorded, but it was stated not to have been great. We may perhaps take the total additional weight involved in the fitting of the ship with the tanks as 200 tons, which is equivalent to about 1·4 per cent. of the fully loaded displacement. When in full action, the tanks were calculated to be capable of exerting a turning moment on the ship of 2790 foot-tons. This figure seems to be calculated on the assumption that in full action the water would flow completely out of each tank in turn, its fellow at the same instant being all but completely filled with water. It is to be noted that even in this extreme action, about a third of the water, namely, that in the lower connection would contribute nothing to the stabilising effect.

The first experiments with the "Ypiranga" were made at the end of March, 1910, and during the summer of that year the effect of the anti-rolling tank system was thoroughly studied on the regular voyages of that vessel and her sister ship across the Atlantic. Under average conditions of weather it was found that with the tanks in action the vessels had become quiet and comfortable. By means of a specially designed, long-period, recording-pendulum, continuous rolling diagrams were taken with the tanks in and out of action. In general terms, it may be said that the effect of the tanks was to reduce the heeling of the vessels from a maximum of about 11 deg. to a maximum of about 2 deg. to 2½ deg. On the "Corcovado," under average weather conditions, it was noted that the reduction of the rolling was substantially as satisfactory with one tank—the fore tank—out of action, as when both were in action. In December, 1910, the "Corcovado" encountered very rough weather in the middle of the Atlantic. With both tanks out of action, maximum heeling angles of 18 deg. on each side of the vertical were recorded. When the foretank was brought into play, the maximum heeling angle was reduced to about 10 deg., and when both tanks were brought into use the maximum angle of heel recorded was 3 deg. to 4 deg.

Before leaving these two vessels, we may record a few figures concerning the effect produced on their general stability characteristics by the addition of the tanks. On December 12th, 1910, the "Corcovado," on a voyage from Havana to Vigo, was drawing 22·4ft., corresponding to a displacement of 11,600 tons. With the anti-rolling tanks empty, her metacentric height was 3·35ft., and her radius of gyration 21·55ft. She made 4·62 rolls per minute—out-to-out and back again—corresponding to a periodic time of 13·0 sec. With the anti-rolling tanks filled with water, her metacentric height was reduced to 3·02ft., her radius of gyration was unaltered, and her periodic time was lengthened to 13·7 sec., corresponding to 4·38 double rolls per minute. In explanation of the fact that the radius of gyration was not affected by filling the tanks with nearly 200 tons of water it may be suggested that when the tanks were filled an equal weight of water was discharged from the compartments in the ship's double bottom.

Following the success obtained with the Frahm tank system on these two vessels, numerous German and other ships were built with tanks forming part of their initial structure. Among these vessels were the Hamburg-America liners, "Amerika," "Meteor," and "Kaiserin Auguste Viktoria," the Woermann liner "Eleonore Woermann," and the Cunard liner "Laconia." In Fig. 8 we illustrate as typical of these installations the tank system fitted in the "Laconia." The tanks in this vessel were arranged in the foremost athwartship bunker space. Each wing tank was divided by a water-tight bulkhead into two portions of unequal size, so that three different degrees of stabilising effect might be available to suit varying conditions. The two smaller wing portions were connected by a lower water limb placed on top of the ship's double bottom, and by an upper air connection placed under the main deck. The two larger portions were connected similarly, but separately. The water spaces of the wing tanks were carried down into the bilges, and could be emptied by means of the bilge pumps. The tanks and lower water connections had a total volume sufficient to hold 580 tons of water. When in use for stabilising purposes, they were charged with 320 tons of water, equivalent to about 1·28 per cent. of the normal displacement of the vessel. The water in the stabilising system was distributed roughly in the proportion of 20 per cent. in the two water connections and 40 per cent. in each pair of wing tanks. Records are not available of the behaviour of the "Laconia" with the tanks in and out of action. The vessel was torpedoed and sunk during the war and is not to be confused with the company's ship of the same name which is now in service. It may be inferred, however, that the results were deemed encouraging, for subsequently the "Aquitania" was built with an installation of Frahm tanks. Here again we can obtain no information from the owners as to the results achieved except such as may be inferred from the statement that the

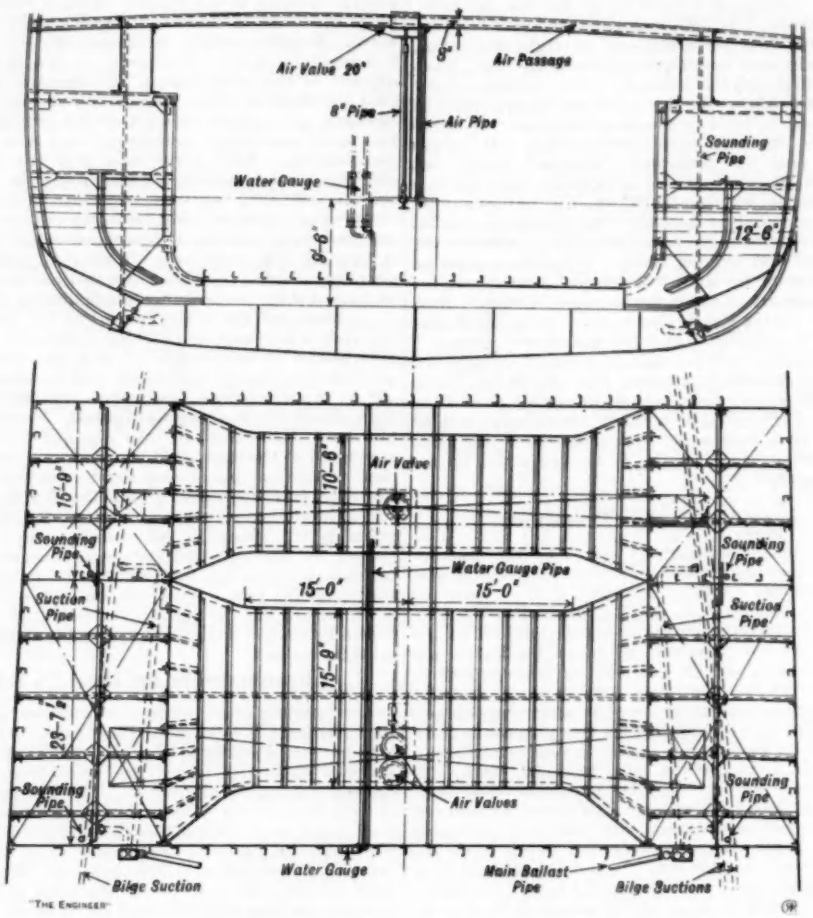


FIG. 8—ANTI-ROLLING TANK SYSTEM OF CUNARD LINER "LACONIA"

tanks, while they still exist in the vessel, are now used simply for the storage of fuel oil.

In vessels built in the years before the war the plan adopted in the case of the "Laconia" of placing the tanks well down in the hull and arranging the lower water connection on top of the double bottom was generally followed, because so arranged the adoption of the system interfered to the least possible extent with the availability of the space within the hull. It will be gathered from a comparison of the "Laconia" and "Ypiranga" installations that satisfactory results from the stabilising point of view are not greatly affected by the precise height at which the tanks are situated. In 1913, however, Mr. Lloyd

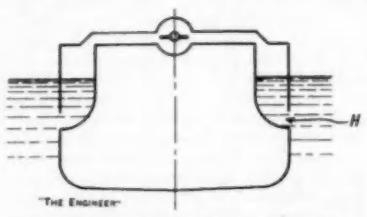


FIG. 9—MODIFIED FRAHM SYSTEM

Woollard proved mathematically that best results would be obtained by placing the tanks as high as possible in the ship, with the horizontal water connection near or above the ship's centre of gravity.

Up to the outbreak of the Great War thirty-three vessels, aggregating 660,000 tons displacement, had been fitted with Frahm anti-rolling tanks. From 1914 to 1918 further application of the system in mercantile vessels was interrupted, but in the German Navy the invention was usefully applied in six destroyers—"B 97," "B 98," and "B 109" to "B 112"—and one small cruiser. Two other small cruisers and twelve additional destroyers were planned to be fitted with the system. In all these cases the added weight represented by the water in the tanks

* No. III. appeared April 18th.

would have been a serious objection to the use of the invention. In place of water, therefore, use was made of the boiler fuel oil.

The stabilisation of submarines provided a very important application for the system. In the first instance three small submarines of the "B" type were fitted with Frahm anti-rolling tanks. Then a series of larger "E" type boats followed. The first armed submarine cruiser and all subsequent vessels of this type, including the so-called commercial submarines, were subsequently stabilised on the Frahm system. By the end of the war, seventy-two submarines, having an aggregate displacement of 128,000 tons, had been completed or were being built with Frahm tanks worked into their structure.

The application of the system to submarines led to an important change in the design of the tanks, a change which has since been perpetuated in some post-war mercantile vessels. The absence in submarines of room for the cross water connection led to the revival of a modified design which was almost contemporaneous in its inception with the design which we have so far been dealing with and which had given promising model results. This modified design is illustrated diagrammatically in Fig. 9. The side tanks, as before, are connected by means of an upper air passage, containing a throttling valve. They are, however, not joined by a lower water connection inside the hull, but are open through ports H to the sea. The tanks are so placed that when the vessel is floating on an even keel in still water they are about half full, the level of the water inside the tanks being the same as the level of the water outside.

It is obvious that if the ports H on the two sides of the vessel were connected by a pipe running round and beneath the hull, so as to isolate the water in the tanks and in the pipe from the sea water, the system would in principle be identical with the earlier Frahm system. That this imaginary pipe can be dispensed

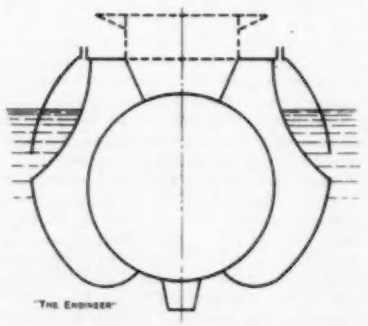


FIG. 11—FRAHM TANKS ON GERMAN SUBMARINE

with in practice and that the sea itself can in effect be used as the lower water connection of the earlier system is not perhaps obvious at first sight. The diagrams given in Fig. 10 may help towards an understanding of the facts.

If the vessel floating on an even keel as at A is heeled very slowly to the position B the water level inside the tanks will adjust itself to the external sea level. In order that the configuration indicated at B may arise the heeling of the ship must occupy sufficient time to allow the required amount of inflow into the port tank and outflow from the starboard tank to take place. The rate of inflow and outflow is governed by the size of the openings in the hull, and by the resistance applied by the valve to the passage of the air through the upper connection from the one tank to the other.

If the vessel could be heeled infinitely quickly there would be no time for the flows to take place, and the configuration indicated at C would arise. If the heeling is neither very slow nor infinitely rapid, some such intermediate condition as that shown at D will be produced.

Let us suppose that from the position D the ship is released and allowed to oscillate as she will. At the instant of release hydraulic heads are in existence, causing water to flow into the port tank and out of the starboard tank. These flows will, after an interval of time, result in the disappearance of the heads. This interval will be shortened by the fact that the ship in recovering the vertical position is also helping to make the heads disappear. The combined effect must, therefore, be to make the heads vanish at some angle short of the vertical. A force, even though it is a diminishing one, causes the velocity of a body to which it is applied to increase continuously until it is removed or falls to zero. For example, the velocity of a pendulum is a maximum at the foot of its swing; that is to say, at the instant when the turning moment applied by gravity becomes zero. For this reason the upward and downward velocities of the water in the port and starboard tanks respectively continue after the heads producing them vanish, and as a result the ship reaches the vertical position with the water elevated in the port tank and depressed in the starboard tank, as shown at E.

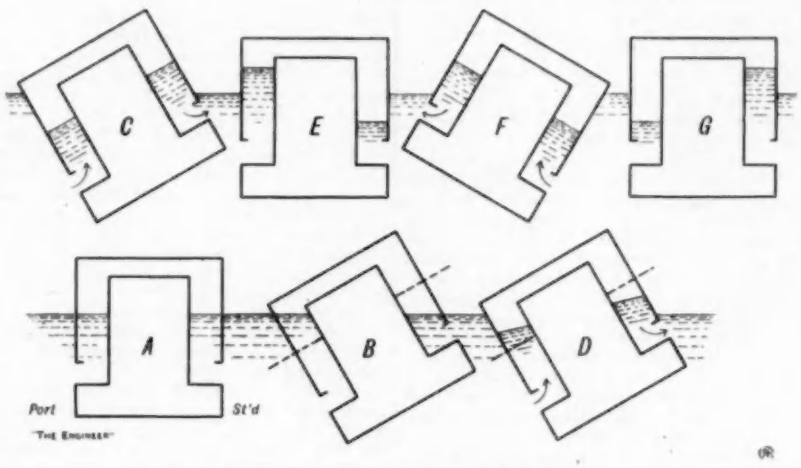


FIG. 10—ACTION OF THE MODIFIED SYSTEM

The heads now in existence are such as to cause a reversal of the flows, and it is to be noted that during the ensuing movement of the ship to starboard the heeling of the vessel encourages these reversed flows. If the size of the hull openings and the resistance of the air valve are correctly adjusted, it is possible to secure the result that there shall be equal quantities of water in the two tanks at the instant when the ship reaches the out-starboard position, as shown at F.

Although the heads shown at E have now disappeared, the heeling of the ship has created new heads, acting to continue the flows out of the port tank and into the starboard. These flows will, after an interval of time, cause the heads to disappear, and this interval will, as before, be shortened because the vessel is now recovering from her starboard roll, and thereby acting by her own motion to make the heads disappear. The heads will therefore vanish at some angle of recovery short of the vertical. As before, the velocities of the water downward and upward will continue after the heads have vanished, and as a consequence the ship will recover the vertical with the water depressed in the port tank and elevated in the starboard, as shown at G.

During the ensuing roll to port the conditions are precisely of the same order as those prevailing during the roll from E to F. The ship will therefore arrive at the out port position C with equal quantities of water in the two tanks.

The configuration C is merely a more advanced development of the configuration shown at D, and therefore the cycle now repeats itself in the sequence C E F G C . . .

It is not convenient to continue the discussion further without the aid of mathematical analysis. Our object in any event is merely to show that the "water pendulum" effect, clearly present in the earlier Frahm system, is equally existent in the modified form. The demonstration of that fact is, we think, covered by the discussion we have given. It may, however, be added that the diagrams given in Fig. 10 can with further study be made to reveal the fact—a fact confirmed by mathematical analysis—that the action of the Frahm system cannot be perfect until the vessel has executed three or four rolls. During the first few rolls the water does not reach the configuration shown at C or F until a short time after the vessel has passed the extreme out positions. The maximum height of the water in the port and starboard tanks, in addition, is not reached until a short time after the ship is vertical. With each succeeding roll, however, the time lag becomes less less and in a very short while disappears altogether.

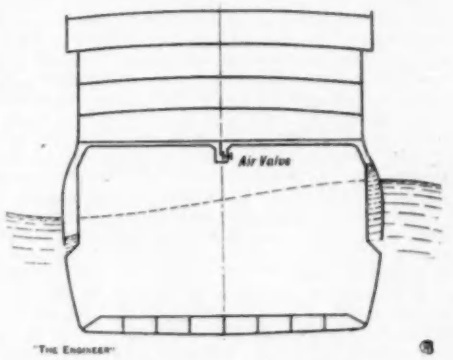


FIG. 12—FRAHM TANKS ON "DEUTSCHLAND," ETC.

A little reflection will show that just as it is possible to dispense with the lower water connection of the earlier Frahm system so, too, the upper air connection can be omitted. Since the water falls in one wing tank to the same extent as it rises in the other, the pressure in the air connection is at all times constant or substantially so, except in so far as the resistance of the regulating valve may induce a slight difference. It is evident, therefore, that the action of the system will not be interfered with if the cross air connection is suppressed and if each tank is connected separately and directly to the free atmosphere. The only change introduced by this modification is the elimination of the ability to regulate the period of the water pendulum effect by the adjustment of the air valve. The period has now to be fixed once and for all by the size given to the water ports and the air outlets.

All the German submarines which were fitted during the war with Frahm tanks were provided with tanks having neither water nor air cross connections.

FIG. 13—WATER PORTS IN HULL OF S.S. "HAMBURG"

In Fig. 11 we give a section of a submarine so arranged. It will be seen that the tanks were accommodated in the space between the outer and inner hulls in which in ordinary vessels fuel oil was carried.

Since the war, the Frahm system in one form or another has been fitted in twenty-one ships having an aggregate displacement of 500,000 tons. The original pattern with water and air cross connections is by no means obsolete. It has been or is being fitted in a number of passenger vessels for the Hamburg-America, Hamburg-South America, Woermann, German East Africa, North German Lloyd and Swedish-America lines. In particular the new North German Lloyd liners "Europa" and "Bremen" have been fitted with the original Frahm tank system. It is claimed that in these two vessels the employment of anti-rolling tanks has made it possible to avoid the use of bilge keels of such a size as would have

greatly increased the hull resistance and decreased the speed. In other vessels the owners have reported that the system has been found advantageous, not only as a means of stabilising the rolling motion, but as a method of carrying additional fresh water supplies and of putting the ballast water to an additionally useful purpose. These secondary advantages are naturally not secured in the modified system in which the tanks are always open to the sea water, and this fact perhaps explains in some measure why the old form still finds favour in spite of the extra room which it requires within the hull.

In the Hamburg-America liners "Albert Ballin," "Deutschland," "Hamburg," and "New York," the modified Frahm system without a water connection but with an air connection is used. A cross section through the tanks of these vessels is given in Fig. 12, while in Fig. 13 we reproduce a photograph of the "Hamburg" in dry dock showing the openings in her hull. The rolling diagram reproduced in Fig. 4 *ante* was, it may be remarked, taken on the "Deutschland" as fitted with this modified form of tank. In these four vessels the hull form is such as to provide a particularly suitable opportunity for the employment of the modified tank system. For two-thirds of its length the hull is bulged outwardly in order to give an increased area at the water line and so to promote inherent stability. The tanks are worked into these bulges and are divided longitudinally into three sections by cross walls. Each pair of opposed tanks is connected by an air passage in which an air valve is situated. The modified system has also been fitted in the passenger steamer "Schwerin," belonging to the German State Railways. In two vessels, the "Cap Polonio" and the "Cap Arcona," of the Hamburg-South America Line, there is to be found a combination within the one hull of the old and the new Frahm systems.

The weight represented by the use of the Frahm anti-rolling tank system, including the water employed in it, is on the average 1·3 to 1·5 per cent. of the displacement. The system has been thoroughly tested in practice over a period of twenty years, and there is ample evidence to show that it is successful and is appreciated by all who travel in the vessels fitted with it. It is neither very costly to install nor intricate in its action. Its disadvantages are of a minor character. The movement of the water in the tanks and of the air through the valve is not completely silent, and if the rolling is excessive the water may acquire an amplitude of swing which will bring it with some force against the tops of the tanks. The stabilising action can be made very quickly effective in the old system by opening the air valve provided the tanks are full. In practice, however, it is usual to run with the tanks empty until their action is called for, and as the filling occupies some time and requires a certain amount of care there may be unavoidable delay in securing the stabilising effect. It may be objected, too, that anything from one-quarter to one-third of the weight represented by the addition of the system to a ship, namely, the weight of the water in the cross connection, plays little or no part in stabilising the ship. All these objections are of a minor order and in any event apply for the most part only to the original form of the system.

Since the invention of the system in 1907 by Dr. Frahm its development and the patent rights in connection with it have been left in the hands of Blohm and Voss, of Hamburg, by whom practically all the vessels which have been fitted with the system have been built. It is not difficult to appreciate the fact that the exact design of the tanks required to stabilise a given vessel is not a simple matter in spite of the simplicity of the action of the system. It is, in fact, said that without the co-operation of Blohm and Voss it is almost impossible for other firms to fit a vessel satisfactorily with Frahm tanks. Some unauthorised attempts were made in certain countries between 1914 and 1918 to apply the system in war vessels, but the results achieved are not known.

(To be continued.)

Institution of Naval Architects.

No. III.*

The first paper considered at the afternoon session on Thursday, April 10th, was that by Colonel Modugno, R.I.N., "On the Final State of a Gas Discharged from a Reservoir into a Space under Constant Pressure." The paper, which was taken as read in the absence of the author, discussed in mathematical terms the subject indicated in its title and illustrated the application of the formulæ arrived at by using them to determine the dimensions of compressed air bottles for submarines and the temperature of the exhaust gases in a four-cycle internal combustion engine.

Gas Discharged under Constant Pressure.

Sir James Henderson, in opening the discussion, remarked that the problems dealt with in the paper arose frequently in certain phases of engineering, and pointed out that by tackling those problems numerically from first principles one could solve them more simply than by the method given in the paper.

Mr. H. G. Williams said that the ordinary everyday use of compressed air in a submarine was happily not that suggested by the author's problem. It consisted rather in the explusion of a comparatively small quantity of water from one or two midship tanks, in order to bring the boat to the surface, when the rest of the ballast water could be dealt with by pumps or low-pressure air. In such circumstances there was plenty of time for the expanding air to take up the heat from its surroundings, and its drop in temperature would only be that between the temperature inside the boat and the water outside. In those circumstances the expansion would be very nearly isothermal, though, of course, one always ascertained the consumption by experiment and not by pure calculation. For purposes of comparison of one submarine with another it was a legitimate practice to state the amount of compressed air stored in the bottles in terms of the equivalent volume of free air calculated by the isothermal law, though it would certainly be incorrect to assume that this volume was a measure of the amount of water which would be expelled from the ballast tanks without recharging the bottles.

Behaviour of Two Passenger Vessels.

The next paper was by Dr. B. C. Laws, on "The Behaviour of Two Passenger Vessels during a Voyage to and from Australia." An abstract of it is given on page 469.

In the discussion Dr. James Montgomerie emphasised the value of the paper, not only as representing the first instalment of an accumulation of valuable data, but also as representing an endeavour to solve some of the outstanding problems which appeared to be incapable of solution by purely theoretical investigation or speculation. The results of the application of theory to problems of design and construction were not invariably in agreement with the actual results. That theory was usually founded on assumptions of certain ideal qualities and characteristics of the materials of construction, and it was hoped that such observations at sea might enable us to arrive at some estimate of the real value of important and unknown factors, and to combine the data obtained into something like formulæ which would be helpful for general application. Commenting on the first part of the paper, which was concerned with investigations made by Dr. Laws of the stresses occurring in a superstructure, Dr. Montgomerie recalled that some years ago he had made an investigation of superstructures, in the course of which he had investigated a great number of first-class passenger liners fitted with long erections, both with and without expansion joints, and it had become clear at that time that many things were happening which could not be explained by the ordinary theory covering these cases. It seemed plain to him, for example, that the fitting of expansion joints did not relieve the superstructure of stress, and that they might have the effect of concentrating stress on the main hull below. That was reasonably to be inferred from Dr. Laws' results, and also from the damage recently sustained by a well-known Atlantic passenger steamer, which damage had occurred directly below the expansion joint. Dr. Montgomerie added that he had found fractures in houses, the length of which should, on the accepted theory, have freed them from any participation in structural straining, and it was also plain that, in close proximity to the expansion joints, severe conditions of stress existed in the material of the superstructures, and, that, again seemed to be borne out by Dr. Laws' results. Dr. Laws had attributed this concentration to the effect of wind pressure, and to the angular momentum of the vessel when pitching; but, of course, it was impossible to establish a relation between those two supposed causes. In his opinion, in the majority of cases, the effects often observed were produced more by the angular momentum of the vessel when pitching than by wind pressure, as it was frequently observed that, as previously stated, damage took place in the material of a superstructure close to the expansion joints, where the element of wind pressure was quite eliminated.

Dr. A. M. Robb was severely critical of the author's method of ascertaining the deflection, bending moment and shearing force for vessel A, and regarded it as extraordinary and unjustifiable. The best way to obtain a realisation of what the author had done, was, he said, to consider the ship up-ended, sitting on a counter, with the weather deck as a wall and the superstructure as a cantilever, the cantilever being loaded by the wind pressure. The author had measured the relative deflections of the superstructure and had proceeded by successive differentiation to ascertain the bending moment and shearing force. Successive differentiation, however, was always very tricky. The old beam theory had at times been slightly abused, but the treatment in that case was far beyond slight abuse; every fundamental idea was ruthlessly cast aside. It was hardly necessary to go into details as to how far a superstructure projecting out from a weather deck fell short of our ideas of the beam.

Mr. J. Lockwood Taylor, discussing the author's conclusion that the effects of angular momentum and wind pressure were of the same order, said that he was not prepared to question it, because there was no basis given in the paper for the calculation of the effect of angular momentum, but he suggested that both those effects were entirely negligible in that connection as compared with discontinuity of the break—the transmission of the stress from the superstructure to the upper deck—and that that would account for all the straining which had been observed, and which the author had called "racking."

Professor P. A. Hillhouse emphasised the importance of eliminating creaking, which was most distressing to ocean travellers, and asked whether the use of blacklead or felt in the joints, as used in yachts, had prevented the creaking on those cases. There were differences of opinion as to whether creaking was due to steel work or woodwork; steel work, of course, must stretch, bend and deflect, but if the creaking were due to woodwork, he asked if it would be possible so to sustain the woodwork in the ship by some elastic supports that it did not move with the steel. He asked whether creaking occurred in warships, which contained less woodwork than merchant ships.

The President assured Professor Hillhouse that it did.

Mr. F. W. Thorne, who emphasised the need for more knowledge of the materials used in ships and the stresses to which they were subjected, said that information such as that given in the paper would help us to acquire that knowledge. Although we calculated stresses by means of the beam theory, the factor in front of the beam formula had, he said, to be deduced from practical experience and Dr. Laws had, at any rate, made a start in recording that practical experience. After pointing out that two materials having similar ultimate tensile strengths and similar elongation might have entirely different fatigue limits, he asked Dr. Laws for more details of the strengths of the steels used, their fatigue limits and their compositions.

Mr. John Anderson considered, as the result of his experience, that we were still at a stage at which such delicate problems as those dealt with in the paper could not readily be treated mathematically. He recalled that, whilst travelling on a large ship, 580ft. long, during ideal weather conditions, he had heard continuous creaking in the superstructure, but that although he had examined the whole structure he had not been able to locate it. His opinion was that it was due to local troubles, and that opinion was supported by the results of experiments carried out on board the "Prometheus," a vessel built for the Blue Funnel Line. The experiments were purely static, measurements being made by special extension meters invented by Mr. Foster King. The meters were distributed over the whole length of the ship and, in general, the results obtained had compared fairly well with the calculated results, except at the breaks of the superstructure; that was where the creaking usually occurred.

Mr. J. H. Narbeth, after emphasising that the investigations described in the paper had been worth while and that the results were of a most practical and helpful character, mentioned that in H.M.S. "Dreadnought" two expansion joints were provided in the flying deck, and the motion at those joints was very perceptible even in seas 300ft. long and 9ft. to 10ft. high. He urged that further investigations as to the effects of different forms of waves would be valuable in promoting more economical construction by showing where scantlings might be reduced.

Mr. T. R. Thomas, of the British Corporation Register, suggested that up to the present our minds had been rather concentrated on the necessity for providing sufficient material in the deck, and that it was only those who had been intimately connected with the scheming of the structural arrangement of deck houses who realised that a very important matter was that of the web of the girder. Dr. Laws had chosen a very fortuntae example of a ship which might show movement in the superstructures. Fig. 4 showed that the promenade deck and the shade deck were not efficiently connected by a web of sufficient stiffness, because there was a doorway which completely cut the web right through and at every window the web was virtually cut right through. He did not understand how Dr. Laws had considered the front of the superstructure to be a beam, but, having done so, it was not surprising that he had obtained a very low modulus from his calculations. He was dealing with a structure which was so inefficient in respect of the web of the girder that it was almost bound to show a very low modulus.

Dr. Laws, in the course of a very brief reply, which he promised to amplify in writing, said that astonishment had been expressed as to the values of stresses shown in the diagrams and tables in the paper, values two or three times as much as the normal values having been obtained. It was helpful to consider in this connection, he said, that if a material were subjected to a static load the stress had a certain value. If the load were applied suddenly, a stress of double that value was obtained, and if one suddenly changed the direction of the stress, the value approximated to three times the original value. That was the experience in experimental work; that sort of thing was going on continuously in a ship, and what was experienced in a laboratory was very likely to be experienced in a ship structure also.

The Stability of a Vessel with a List.

The next paper was by Mr. F. H. Alexander, and was entitled "The Stability of a Vessel with a List." The "list" considered by the author was the heel

* No. II. appeared April 18th.

maintained by a vessel in still water produced by an unbalanced distribution of her contents and excluded heel produced by wind pressure. The author's principal conclusion was that to correct a starboard list it is, in general, better to fill a port tank than to empty a starboard tank. If the list is corrected by pumping out a ballast tank on the side towards which the ship is heeling, an upsetting moment, increasing the list, will be developed during the early stages of the pumping operations.

Mr. H. E. Steel, of the Board of Trade, after discussing stability curves in some detail, called attention to the confusion of mind existing as to the exact meaning of GZ, or righting moment curves. He had heard it stated quite recently, he said, that when a vessel reached the angle of maximum GZ she rolled down the other side of the curve and capsized. That was partially true. What actually was meant was that when internal forces heeled a ship permanently to the angle of maximum GZ shown by the basic curve of stability, she really had no reserve of righting arm or moment, and therefore did capsize from that position. When she was heeled by external forces, such as wind, however, it might be said that she went down fighting, *i.e.*, she resisted capsizing right up to the angle of vanishing stability indicated by the basic curve, and if the upsetting forces were removed at any time before she reached that angle she would tend to recover. In the case of a well-decked ship which had listed and capsized, he had found that if her GM were 8in., although her range of stability shown by the basic GZ curve would be 58 deg., a possible shift of cargo and bunkers might heel her to 32 deg., the angle of maximum GZ, from which inclination she would capsize irrespective of the additional effect of wind and waves.

Sir Westcott Abel said that we were apt to talk rather glibly about standard metacentric height, which, for vessels of low freeboard, was liable to lull us into a false sense of security, particularly as in such vessels conditions might arise after loading and when at sea, which might reduce to a dangerous point the *real* stability of the vessel. We must get away from measuring the standard of stability by the initial metacentric height. As an example of his point, he said that if the centre of gravity were 24ft. above keel when the ship was just upright, a rise of only 1½in. might produce a heel of, perhaps, from 8 deg. to 10 deg.

Mr. A. L. Ayre said that to some it would seem that a substantial positive GM should be the only aim, as if it were a cure for every ill, not recognising that stability, as represented by GM, or even range, was frequently exceeded in importance by other practical conditions that might occur. It was indicated clearly by the paper that there were other conditions of far more real and vital importance than stability itself. The effect of flooding the 'tween decks, as illustrated in the paper, was shown to be of the utmost importance, and clearly pointed to the fact that such an accident was one, like many others that might arise, for which GM should not be regarded as a safeguard against the consequences.

Mr. H. S. Pengelly said that the stability of a vessel with a list due to an athwartship movement of the C.G. differed from the ordinary stability in that there was a lack of symmetry. When the list was considerable and the freeboard upright not large, that lack of symmetry, as shown by the author, might be important. In such a case, as was stated at the conclusion of the paper, there should be complete understanding of the conditions causing and accompanying the list. In warships, and particularly large warships, it was usually possible to arrange for a number of compartments well distant from the middle line capable of being flooded—or emptied—to correct heel. Flooding boards showing the effect on draught and heel due to separately flooding each compartment below the water line were supplied to each ship. In using this information it was usual for ship's officers to assume that the effect of flooding a number of compartments was the algebraic sum of the effects of flooding each compartment separately. That was often a sufficiently accurate assumption, but, in certain cases, a complete understanding of the problem was necessary, if flooding, &c., was to be accompanied by successful results. A general idea of the stability of a ship when heeled, owing to a transverse movement of the C.G., could be obtained from the ordinary stability curve, by changing the base line of the curve, by joining the original base line at 90 deg. to the GZ curve at the angle of list. Accurately, of course, the new base line should be a cosine curve through the two points, but the error in assuming a straight line, which did not err on the side of safety, was not usually large.

Mr. Alexander, replying to the discussion, said that when he had stated that the pumping out of tanks should not be attempted unless there was a complete understanding of the conditions, he had really meant that it should never be done at all. Replying to Mr. Ayre, he said that it was quite possible that the vessel referred to as being liable to have the 'tween decks flooded, would have more satisfactory stability with a GM of 0, because she would develop a list with a very much smaller disturbance, and yet, when she had attained that list, she would have a reasonable stability curve beyond the list, whereas in the case of a vessel which started with a good high GM and then attained a list, and it was combined with small freeboard, one knew that it was something pretty big that had caused the list, and that there was very little remaining to go upon in the way of stability. In reply to Mr. Pengelly, he said that he had tried to show in the paper by diagrams, rather than by curves and calculations bringing in trigonometrical functions, and so on, something that would be easily understood, and he agreed that by means of some simple sketch diagram which the shipmaster could make for himself he might be able to grasp the character of the stability of his ship. He was sure, he continued, that much that had been written for the purpose of guiding shipmasters was not likely to be studied by them; something simpler was wanted, and he felt that some sort of diagrams showing the effect of water ballast, and so on, might be embodied in a little book in order to show graphically facts which were not easily grasped by reference to text-books such as were used by naval architects. When stating that to correct a starboard list it was better to fill a port tank than to empty a starboard tank, he had had in mind vessels in which there was no possibility of transferring from a starboard to a port tank. He had not been thinking of warships, but he quite realised that if, instead of having to fill the port tank from outside, one could transfer water from one side to the other, and thereby avoid change of freeboard, the latter was a much better means of correcting list.

The next paper taken was presented by Professor Coker and Mr. Coleman, and was entitled "Stress Distribution in Notched Beams, and their Application." A short abstract of it is as follows:—

STRESS DISTRIBUTION IN NOTCHED BEAMS.

In the construction of ships' hulls it is occasionally the practice to make expansion joints in the upper part of the structure, which are formed as transverse cuts across the ship and of considerable depth. It is not uncommon to find these cuts as much as 25ft. deep, measured from the top deck, and 100ft. apart, in a large vessel. The effects of these discontinuities on the stress distribution in the hull must be considerable, and, moreover, difficult if not impossible, to calculate. Some approximate idea of the change in the stress distribution caused by expansion joints may be obtained by examining the effects produced in a simple beam of rectangular cross section when under pure bending moment of known amount, when there are no transverse slots cut in it, and also when one or more of these discontinuities are present. In the experiments described in the paper the beams used were of transparent nitro-cellulose and were examined under polarised light. An ordinary beam without a slot shows a straight central black band denoting the neutral axis, with parallel rainbow bands so spaced as to indicate that the stress at any point in the beam is in linear proportion to the distance of this point from the neutral axis. If a central slot is cut in a beam a very great modification of the stress takes place. Chiefly remarkable is the cluster of colour bands round the bottom of the notch indicating a great intensity of tension stress. On the rest of the beam, well away from the notch, the colour scheme indicates the usual linear distribution. The upper angles of the notch are almost indistinguishable from the background, so that there can be little or no stress at these points. The effect of two notches, cut in a beam, was also studied. The principal feature of interest is that the upper part of the beam between the two notches is under considerable stress, and therefore takes a share in resisting the external bending moment, while the stress distribution at the ends of the notches is much the same as before. If the upper part of the beam between the two notches is cut away the central part of the beam reverts to simple bending stress of the usual type, but modified near the ends by the abrupt change to the greater depth of the beam. Great stress intensity is observed at the two internal angles, and practically complete absence of stress at the projecting angles. The effects produced by three notches in a beam are very similar to the above. It is important to notice here, as before, that the effect of a number of notches of this kind, although no doubt they impair the strength of the beam, yet they do not deprive the intermediate length between notches of stress which assists in balancing the external bending moment. It can be concluded therefore, that, if the hull of a ship is notched in this way, the superstructure will still carry some of the bending moment.

Mr. A. T. Wall pointed out that the beams dealt with in the paper were solid, whereas ships were by no means solid, and obviously a ship was a very much more complicated case than those dealt with in the paper. But, on the other hand, from the very fact that the ship was, so to speak, a hollow ship, one had more chance of doing something locally. The question of strengthening around openings in superstructures was always with us, and Professor Hill-house had been responsible for introducing a very valuable method of stiffening at the corners of doors and large windows. It consisted of a doubling plate placed around the corner of the opening, and the important point about it was that the doubling was welded on instead of being riveted on. He urged that, after the corners were prepared—naturally, they should be rounded corners—the plating should then be filed around those corners, because if one gave the stress an irregularity to start away from it would take it, and one's chances were not nearly so good as they would be otherwise.

Mr. E. B. Moullin said that his chief interest in the paper was in the effect of expansion joints on the natural frequency of two-node and three-node vibrations of a ship's hull. To estimate the natural frequency it was necessary to calculate the strain energy in the structure, and to do that it was all-important to know whether the expansion joints were successful in relieving sensibly all the stresses from the superstructure. For example, if one were to evaluate the frequency by the simple formula due to Schlick, namely, $n = C\sqrt{I/W l^3}$, where I was the moment of inertia of the midship cross section, should I be reckoned only to the bottom of the expansion joints or should all the superstructure up to the boat deck be included? Clearly, the decision would affect enormously the value predicted for n. It was common practice, he believed, to assume the expansion joints were so successful that I was reckoned only to the underside of the joints. Whether or not that was so, he had for long thought that such a practice would be grossly incorrect, and he had made some vibration experiments which confirmed that view.

Dr. A. M. Robb, discussing the stress at the corners, expressed the view that the authors had rather overstated the case against the expansion joint, and said that it was not at all necessary to overstate it. It seemed, from the examination of previous papers, that the increase of stress at the notch was intimately associated with the relative thickness of the material above and below the level of the notch. If the beams were of reduced thickness above the level of the notch the very great increases of stress shown in the paper would probably not be found, and the state of affairs would be a more reasonable approximation to the actual case of an expansion joint in a light structure above the main structure of a hull.

Mr. H. S. Pengelly said that a practice followed at the Admiralty with regard to capital ships was to calculate the stress of that part of the ship from the protective deck down to the keel, on the assumption that the upper part had been destroyed, and the experiments described in the paper seemed to apply to that case more than to well-designed expansion joints. From that point of view the results were of considerable interest, although it was clear that the bending of a solid beam of the nature dealt with was hardly the same as the bending of a ship with decks, which might be called a hollow structure.

Professor Coker, referring to the criticism that the beams dealt with in the experiments he had described were not the same as a ship, pointed out that professors had not the money with which to build ship's hulls, but if any shipbuilder would build a hull for them they would be pleased to test it—and they would probably get very much the same results. He regarded the doubling plates mentioned by Mr. Wall as being extremely good, and their use indicated an appreciation of the great increase of stress at an angle. Replying to Dr. Robb, he said that he might have overstated the case in regard to the expansion joints, but that he had simply put down the results for the solid beam, and they were correct so far as they went, but they had not taken into account the alteration in section at the upper deck and upper works, and that might produce a considerable change in the bending moment.

The meeting then adjourned until Friday.

On Friday, April 11th, the chair was taken at both the morning and the afternoon sessions by Sir John Biles, who apologised for the absence of the President through other engagements.

The secretary read the names of new members and the list of transfers, and comment was made on the satisfactory position, there being 170 new members and 35 transfers from one class of membership to another, a total of more than 200.

Sir William Berry then proposed an alteration to the by-laws, the object of which is to widen the scope of the activities of the Institution and, incidentally, the membership, to include airships and seaplanes and their engines. By a new by-law—No. 36a—it is laid down that the word "ship" or "ships" shall be deemed to include airships and seaplanes; the words "shipbuilding yard" shall also mean establishments where ships, airships or seaplanes are built, and the words "shipbuilding" and "marine engineering" shall include the construction of airships and seaplanes. In the same way the words "marine engine works" occurring in the by-laws, shall be deemed to mean establishments in which the main propelling machinery is built or such auxiliary engines as are of primary importance. It will be seen that these alterations widen the scope of membership and permit of the makers of important auxiliary machinery being admitted as members as well, of course, of those engaged in the design and construction of airships and seaplanes.

The new by-law also includes a definition of "position of responsibility" and "apprenticeship or pupilage," which are also drafted to widen the scope of membership.

Sir Robert Dixon seconded the adoption of the amendment of the by-laws, and the Council's proposals were unanimously accepted.

VIBRATION OF SHIPS.

The following two papers were then presented and discussed together:—"Causes and Prevention of Vibration in Motor Ships," by Robert Sulzer, of which an abstract is given on page 468 of this issue, and "Vibration of Ships," by Dr. J. Lockwood Taylor, of which the following is a brief extract:—

The paper describes some results obtained by means of the Cambridge low-periodicity vibrograph. The elimination of vibration in the design stage, as distinct from elimination by a process of trial and error in the finished ship, requires a thorough understanding of the dynamical properties of the hull, and of the action of different types of machinery in setting up movement of the structure. Accordingly, the primary object of the work was the quantitative correlation of the results of calculation and of actual measurement on board ship. The paper is in five sections. Section I. deals with the causes of vibration encountered; Section II. compares observed and calculated frequencies; Sections III. and IV. deal with the amount of damping and the amplitude of vibration; Section V. discusses the balancing of machinery in the light of the amplitude calculation.

The vibrograph is capable of recording either horizontal or vertical movement and is designed on the principle of a seismograph. The natural period of the instrument is adjustable to

a maximum of about 2·2 and 1·5 seconds for vertical and horizontal vibrations respectively, which is about three times the period of the slowest vibrations of each type actually met with. The instrument is very sensitive and readily records amplitudes of the order of $^1/_{1000}$in., and it has thus been possible to record free vibrations of the hull and to measure the damping coefficient, it is believed, for the first time.

The conclusions so far arrived at are as follows :—

(*a*) The frequency of the lower modes of vertical and horizontal vibration may be estimated with reasonable accuracy, without the aid of empirical factors or assumptions.

(*b*) The order of the amplitude due to known unbalanced forces may be estimated and, hence, the permissible force. (If an acceleration of 0·5ft./sec.^{2} may be tolerated, the permissible amplitude, or half the total movement, in inches, is 0·15 T^2, T being the period of vibration in seconds.)

(*c*) The damping being small, the critical range in any particular condition of loading is small; for a cargo boat, the displacement of which may vary considerably, the total range to be avoided is considerably increased.

(*d*) The small degree of damping means that a relatively small force is effective in causing vibration, when resonance occurs, the "dynamic magnifier" being large. If resonance cannot be avoided, the balance requires special consideration.

(*e*) It is not sufficient in general to consider only unbalanced forces and couples, *i.e.*, "static" and "dynamic" balance respectively; for a relatively long engine the "internal" balance must also be considered. An engine balanced as regards the first two factors may still cause vibration, and if forces or couples exist the effect of the third factor may act either in opposition to, or in conjunction with, the first two, depending on the type of engine and its position in the ship.

(*f*) With regard to the question of vibration in general, apart from structural vibration in particular, the question of resonance is fundamental, since the forces acting are not usually sufficient to cause serious movement unless their effect is magnified in this way.

Engineer-Commander C. J. Hawkes, speaking on Mr. Sulzer's paper, said that no details had been given as to the method of calculating the critical speeds. If the author had taken into account the effect of the entrained water, what figure had he used? Also, was the same figure taken for all propellers and what justification was there for the figure assumed? Mention was also made in the paper of the maximum stresses likely to be reached during the critical periods. It was suggested that the stresses had been calculated from the measured amplitudes, but that did not appear to be the case from the diagrams. It rather appeared that they had been calculated from an assumed damping factor, otherwise the stresses would be infinite. What damping factor was assumed and was the factor the same for each type of engine, or did it vary with the dimensions of the engine? There was no mention in the paper of the possible vibration due to the propeller blades and, therefore, he assumed that that trouble had not been experienced. From experiments he himself had made with model propellers, he had found that no such vibration was set up unless the clearance between the tips of the propeller and the frame was reduced to a very small quantity.

Mr. A. T. Wall said that vibration was one of the biggest bogies that had to be dealt with, but the whole matter was a very difficult one. The natural periods of ships varied very much with the loading, and whilst that was not a difficult matter in primarily passenger ships or pleasure craft, it was a very important matter in the intermediate type of vessel. Although he congratulated Mr. Taylor that his calculations agreed so closely with the periods observed, he was bound to say that that was not good enough. If they were running at 200 r.p.m. it might be found that there was bad vibration at the very revolutions it was desired to run at. To increase the revolutions had obvious mechanical disadvantages, and to decrease them was, in effect, taking so much speed off the ship, which was a very serious matter, although it had been done in several ships. Then, different loading had its influence upon vibration. He had in mind the case of a triple-expansion, single-screw ship in which totally unexpected vibration was found at the service revolutions and it was very noticeable in the light ship, but when a certain amount of loading was put into No. 2 hold, the vibration was almost absent. Certain stiffening in the engine-room and modifications to the propeller did not seem to do much good, but, finally, by internal stiffening, the vibration was brought down to something less unpleasant and was made sufficiently satisfactory. The whole trouble was that they did not know what they were in for until the trials, and then it was, of course, extremely difficult to remedy. Mr. Sulzer suggested that it was easy to stop local vibration by additional light stiffening, but when the vibration happened to be in a dining saloon or a lounge that had been nicely decorated at considerable expense, it was not a popular thing to have to interfere with it for the purpose of putting in local stiffening. Therefore, if it were possible to have methods of calculating in advance it would be exceedingly valuable.

Sir James Henderson remarked that Mr. Sulzer dealt with multiples of the fundamental frequencies and impulses, but neglected altogether the submultiples. In a previous paper, when analysing the vibration of the "Mauretania," he himself had stated that the fundamental vibration of the ship was produced by an impulse caused by the propellers which synchronised with the odd harmonic of the fundamental. He was taken to task at the time by a mathematician who proved to his own satisfaction that it was impossible, but he still maintained that it is possible and that care must be taken to avoid vibrations produced by impulses of the odd harmonic which were fundamental. That could be proved by the use of the ordinary apparatus used in physical laboratories for testing the vibration of string. It was possible to get harmonic impulses producing fundamental vibration, and, therefore, it was a matter to be taken into account.

Mr. G. S. Baker, referring to Dr. Taylor's paper, said that in the effect of water upon the vibrations of a ship there were three things—one was the total mass being vibrated; the second was its distribution; and the third was the distribution of the inertia in the vibrating structure. A great deal of the paper was devoted to a consideration of the effect of water, and its distribution, upon the vibration period. In Table I. the masses given were very large compared with the displacement of the ship, and they were very constant despite the difference in the ships. That looked rather suspicious. In Table II. the added mass for lateral motion was given, and it worked out very much smaller than for the vertical, despite the fact that the two sides of the ship were entraining water instead of merely the bottom. That again looked a little suspicious. Then the frequencies calculated in Table I. were all above the true value, and as there were positive signs in places, that also looked suspicious. The conclusion was come to that the effect of water on damping the vibration was unimportant, compared with the friction of the ship, but that was difficult to believe. It was not clear from the paper what precautions had been taken in arriving at the damping curve, and it would be useful to have some details as to how the conclusions were arrived at. A second effect of mass was that if the mass were very large, since we did not know its exact distribution, it was no use worrying over the mass distribution of the hull and contents when we had to add a large unknown mass of water. Therefore, there was no need for any elaborate calculations of the distribution of the mass of the ship since a large mass more or less equal to its own displacement was added by the action of the water, and in that way we could drift back to Schlick's method of ignoring these variations of mass distribution. As a matter of fact, Moullin in his 1928 paper had shown what a small effect the distribution had in preliminary calculations of vibration. If, however, the effect of variations of loading was desired to be known, then it was necessary to go into detail. For making a rough shot at the vibration period of a ship, Moullin's calculations showed that mass distribution was not important. Neither Taylor nor Moullin had given any quick method for taking account of variations of mass except by a fresh calculation, but many years ago Mallock had suggested that frequency should vary as $\sqrt{\frac{w_s}{w}}$, where w_s was the elastic hull weight and w the displacement, *i.e.*, to ignore distribution. He had found that one Schlick constant would cover the vertical vibration in the loaded and light condition, and also lateral vibration in the loaded condition, with such a term in the formula. As he understood that Dr. Taylor was going on with that work, he suggested that he should examine the effect of variation or inertia of distribution along the hull, because that had not yet been done. The object would be to see whether that had any material effect on the frequency. If it could be shown that it was small, it would be possible to use a modified Schlick formula, and thus make these calculations in a very rapid manner.

Mr. R. W. Allen said the subject was the most important with which naval architects and mechanical engineers had to deal to-day. There had been troubles years ago which were not due to workmanship or design or material, but which there was difficulty in understanding. No doubt, it was torsional vibration which caused the breakage of crank shafts. The case mentioned in the paper of a ship equipped with two 4000 B.H.P. two-cycle engines he knew very well. The trouble was traced to the fact that the engines which had been working quite satisfactorily in one type of ship produced vibrations in another. That was all there was in it. The particular ship was designed with many decks and large superstructures, and vibration was set up which was entirely absent on another type of vessel. Hence, it was essential to calculate the natural frequency of the ship and the natural frequency of the engine, and only in that way could we ensure complete success. From the passenger point of view, it was not so irritating if there was a continuous vibration, as if the vibration was intermittent, because nothing was so unpleasant as, for instance, lying in one's bunk knowing that in a few seconds the vibration would come on again and continue to come on and go off.

Mr. E. B. Moullin said that he was anxious to find a method of allowing for the entrained mass of water in the propeller. Mr. Brown and himself were starting on experiments for finding the virtual mass of propellers, and would like to know whether there existed perfectly definite figures, so that they would not waste time doing work that was unnecessary. With regard to torsional vibration, he had been concerned with calculating torsional vibration in aircraft, in which there was no appreciable length of propeller shaft, and the whole of the torsional system was within the engine. It was an extremely troublesome thing to find the effect of torsional stiffness of the crank. The results had been published by the Stationery Office, the work having been carried out on behalf of the Aeronautical Research Board, but he would like to know if Mr. Sulzer had found any other method of calculating the effect of torsional stiffness in the case of marine shafts. It was suggested by Mr. Sulzer that in cases in which the torsional vibration was found where it was not wanted, a remedy was to stiffen the crank shaft and reduce the fly-wheel, so as to put the frequency up higher. It had always seemed to him an arguable point, and whether it would not be more desirable to weaken the shaft and use a heavier fly-wheel, and put the torsional frequency down because if the frequency were put up higher, troubles might be introduced from the upper harmonics.

Speaking upon Dr. Taylor's paper, he agreed that the damping factor for water was extremely small, and said that he had been able to prove it by experiments at Cambridge, in collaboration with Mr. Brown, on baulks of timber.

Mr. W. Hamilton Martin, remarking that the results of many theoretical investigations of hull and engine vibrations were now available, and were of the utmost value to marine Diesel engine builders, said that the practical application of them alone did not suffice. Torsional vibration in crank shafts and intermediate shafting often occurred. Balance weights on crank shafts might add to the internal stresses in the shafting, and especially at the couplings of shaft sections. To what extent were such multi-cylinder crank shafts balanced? It seemed that slight errors in the initial balance of such parts would greatly add to the magnitude of any torsional vibration built up. In naval work, the intermediate shafting of cruisers, &c., was very closely balanced, as well as the propellers. With long intermediate shafting, as used with Diesel engines, the author of the first paper stated that the critical speed lay so low that it was impossible to consider means of removing it above the normal speed ranges, and therefore a very heavy fly-wheel was chosen to keep the critical speed down to a region where the load on the engine was low. Additional torsional stresses in the shafting were thereby also reduced. The greater the engine fly-wheel effect and the lower the propeller fly-wheel effect, the less the action of the stresses. That might be one way to reduce unpleasant outward effects, but did it not, as it were, bottle up the undesirable stresses where they would still act internally in the shafting. If so, there would appear to be additional reason to ensure from the start the greatest possible balance of fly-wheels, crank shafts, intermediate shafting, and propellers. Fly-wheels in particular were liable to affect adversely adjacent bearings or cause vibration in the hull. Had it been definitely proved that a multi-bladed propeller of narrow section and running at higher speeds than at present—and thus suitable for Diesel engine drive—would not give a smoother action and at the same time a reasonably acceptable efficiency? Even ten-cylinder, two-cycle engines might still cause unpleasant effects in vessels without special precautions, notwithstanding those suggested by the author. He noticed from the Dutch journal *Die Ingenieur* that on the trials of a large new passenger vessel, which has two ten-cylinder, two-cycle engines of 7000 H.P. each, the water in the swimming bath set up a strong wave action and splashed forcibly over its edges, although the vessel was in a smooth sea. That was probably due to interference, and the matter was being closely investigated. At the same time, this particular case might have been exaggerated in the report in question. These difficult problems were being investigated by the author in a commendable manner, and his work would no doubt lead to the desired end.

Mr. J. Calderwood suggested that it was very dangerous in this matter to use approximate calculations because they led people to think ships were free from vibration when, as a matter of fact, there was considerable vibration. Again, on the question of balancing, the ordinary methods of balancing were quite meaningless unless there was an absolutely rigid engine. If the engine was on a very flexible framing each of the cylinders acted by itself to create vibration, and a great many instances of bad vibration with Diesel engines had been due to that cause, combined, of course, with synchronisation with the natural frequency. The effect of entrained water in the propeller varied considerably, but from the results of his own and other experience he thought it could be assumed very closely what the correction should be for any propeller. It did not vary within a range of more than 10 per cent. The mean should not be more than 2½ per cent., and an engine was never designed to run within 2½ per cent. of its critical speed.

Mr. J. Reid spoke on the subject of firing impulses, and said that the impression that the horse-power developed in each cylinder was the same was not always correct. In one case he found that whilst the oil was going correctly into each cylinder, the air supply was going in in the most irregular manner, and the result was the most extraordinary inequality in the horse-power developed in the various cylinders. The terrible vibration set up in that case was only cured by reducing the total horse-power of the engines. Another important matter was to enable the operating staffs on vessels to be able to make some use of the information with regard to vibration that was now available. Diesel engine makers should provide a proper line of instruments which would enable the operating staffs to see whether their cylinders, for instance, were each developing the same horse-power, and so avoid what might be serious consequential damage. He did not agree with the suggestion made

by Commander Hawkes that the propeller did not have very much influence on vibration. In a long experience of travelling across the Atlantic he had found that the propeller and the depth of water had a great influence upon vibration. A change in the depth of water often made such a difference to the vibration that a passenger might think the vessel was being manœuvred into dock, but when they looked out they found they were still at sea. Therefore the question of vibration could not be discussed without reference to the propeller and the depth of water.

Dr. Lockwood Taylor mentioned a few points in Mr. Sulzer's paper before replying to the discussion on his own paper. The curve of torque variation for different types of engine also had some bearing on the question of hull vibration, and Mr. Sulzer would only be doing justice to the two-cycle type if he brought out the fact that it was better than the four-cycle type from that point of view. On the question of transference of vibration of the engine, a certain engine was tested on somewhat elastic girders and a certain natural frequency was found which, however, had no relation to the natural frequency of the engine when placed in the ship. This indicated that an engine must be considered in association with its actual foundations in every case. Mr. Sulzer had stated that the whole theory of balancing held in principle only for a rigid engine. Perhaps it would have been more correct to say a perfectly rigid engine, and no engine was perfectly rigid. Moreover, it was not only a question of the rigidity of the engine, but also a question of the ratio of the engine rigidity to the strength of the lateral girders in the foundations and also to some extent upon the ratio of the longitudinal strength to the transverse strength of the foundations.

Replying to the discussion on his own paper, Dr. Taylor said that the solution of the local vibration problem, mentioned by Mr. Wall, would have to be somewhat on the lines of the solution of structural vibration, viz., calculation in advance of the frequencies, although he admitted that we were not in a position to do that yet. As regarded Mr. Baker's remarks, he said that he did not seem to have realised that the virtual mass figures in Tables I. and II. were calculated on a basis shown in the appendix, and that they were also derived from the *Phil. Mag.* paper referred to. There was no empirical or personal judgment required. They were purely mathematical figures. As to the frequency effects, all being in the same direction, that was due to the assumption that the other factors were correct. Mr. Baker had said that the distribution of mass was not known, but, as a matter of fact, it was known fairly well. It was the amount which was in doubt, if anything, and the doubt was quite small, as the figures in the paper indicated. At any rate, to tolerate a known error because the unknown was small did not seem to him reasonable. In advocating the use of Schlick's constant, he took it that Mr. Baker meant it to be applied to the total mass including the water; otherwise the results would be seriously in error. In advocating that, however, Mr. Baker was in direct opposition to Mr. Wall, who seemed to think that even with the refinements in the paper the frequency calculations were not sufficiently accurate.

Mr. Sulzer promised a written reply to the points raised upon his paper.

Owing to the length of time taken in the discussion on these two papers, the paper by Lieut.-Colonel Dondona, which was also to have been read at the morning session, was postponed until the afternoon.

A hearty vote of thanks was accorded the authors and the meeting adjourned until the afternoon.

(To be continued.)

Empire Mining Congress in South Africa.

In delivering his presidential address at the Empire Mining and Metallurgical Congress at Cape Town on March 25th, Sir Ernest Oppenheimer observed that he viewed the invitation to be President rather as a mark of recognition of his work from a public angle than merely an acknowledgment of his endeavours in the sphere of mining enterprise. South Africa was one of the most highly mineralised countries in the world, but if Western civilisation was to be firmly rooted in South Africa, it must be accompanied by, and must consistently encourage, permanent European settlement in such parts of the continent as were suitable for European settlement, and were available without detriment to the legitimate requirements of the native population. Fortunately, such unalienated areas still existed in the healthy highlands that stretch across the sub-continent, and mining could therefore continue its work of creating an enduring European civilisation in Africa. If that was not the inward meaning of our mining development, then mining became a mere exploitation.

Sir Ernest referred to ancient mining industries of Rhodesia, which, while it lasted, must have supported a very large population, though all that remained was the "enigma of Zimbabwe." Mining development had increased the agricultural and pastoral activities of the Union. The same process was now taking place in Northern Rhodesia. That territory definitely held out promise of becoming within a comparatively short space of time the permanent home of a large European population. A vigorous policy of developing mineral resources leading to increased European settlement, was also the easiest, most effective, and most logical way of civilising Nature.

Reviewing the mining history of South Africa, Sir Ernest said that the recovery of diamonds in the Kimberley pioneer days, when only inexpensive equipment was required, produced wealth quickly, which provided capital not only for deeper diamond mining, but also to a large extent for the opening up of the Rand. Coming to modern times, he explained the system of group control adopted by the Rand mines, and expressed the opinion that Northern Rhodesia, which at present was in the pioneer stage, would benefit considerably through the application of group control methods to mining development. Six or seven years ago the general outlook in Northern Rhodesia was most discouraging. Not merely were mining operations stagnating, but they were actually declining. It was then realised that the country was unsuitable for old-time methods. The time had come for scientific systematic work. Opportunities were afforded for this by the British South Africa Company, and the result was the beginning of a new era of development. Pessimism had given way to optimism. The copper belt of Northern Rhodesia now promised to be the greatest mineral discovery of our time. This British-owned copper field was of the greatest importance to the Empire, which was hitherto dependent on outside sources for the bulk of its copper requirements.

Mr. T. W. Gibson, Deputy Minister of Mines, Ontario, related how exploration and discovery have been actively pursued in the last two or three years by the aid of modern inventions, such as the aeroplane, the outboard motor, geo-physical methods, and even wireless communication. The aeroplane, he said, carried the prospector to the remote areas of the Province almost as easily as to the nearer ones, the outboard motor doubled the speed of his travel, wireless kept him in touch with headquarters and dispelled his loneliness and isolation, and, later on, electrical processes tested for indications the ground he had located.

The use of the aeroplane as a vehicle for mining development was further elaborated in an address at the same meeting by Mr. J. A. Wilson, Controller of Civil Aviation in the Department of National Defence, Ottawa. There was no doubt, he said, that the mining areas of Northern Canada had been developed many years ahead of expectation, because of the increased ease of transport provided by the aeroplane throughout a territory hitherto practically inaccessible. Mining engineers and executives had been able to inspect areas hundreds of miles from civilisation. Exploration companies were able to place prospectors in the field without loss of valuable time in travelling, and could maintain them there, move them from place to place, receive regular reports on the progress of their work, prompt news of any important discoveries, and, in fact, control their operations in a way which would be impossible without air transport.

The climate and physical character of Northern Canada were favourable for flying, and the great river systems and the myriads of lakes which covered the whole area, provided ready-made landing grounds, both in summer and in winter. To-day no district in Canada was more than one, or at the most two, days' flight from a railway terminus. Canadian aviation had always been closely associated with the development and conservation of the country's national resources. The forester crying out for better means of transport and observation over the northern forest belt eagerly adopted the seaplane, and the surveyor soon realised the possibilities of the aerial camera as an aid to rapid mapping. The geologist and prospector followed their example and adopted air transport immediately aircraft suitable for their purpose were produced. Canadian aerial transport services were self-supporting, and depend on no Government subsidy or mail contracts, but on the demand for flying from mining and prospecting companies. One company started in 1927 with one machine fitted with skis for winter operations and floats for summer; it now operated thirty-two modern planes, ranging from light craft carrying a single passenger to large machines carrying ten. From January, 1927, to March 31st, 1929, the company carried 13,226 passengers, 195,000 lb of mail matter, and 1,820,314 lb. of freight. The flying time was 10,314 hours, and 850,000 miles were flown, practically all the work being in connection with mining.

A number of exploration and mining companies maintained their own aircraft. Planes on such work were fitted with large fuel tanks to give long range. Bases had been established at strategic points throughout the North, where they might re-fuel. Small parties, consisting of a couple of prospectors with their camp equipment, canoe and provisions, could be put down in any area, left there to work on the ground, and picked up later, according to any schedule which might be adopted. The mobility of the parties was thus greatly increased and much larger areas could be covered in the season. A successful expedition, organised by Colonel J. Scott Williams, visited many remote points over the Yukon. They were away from civilisation for three months and no untoward incident occurred to aircraft or crew, while flights were carried out uninterruptedly over the whole district. One of the finest commercial flights ever undertaken in any country was made in July, 1928, at the request of a mining syndicate. The party consisted of a well-known geologist, a newspaper man, the pilot, and his mechanic, and their equipment included a collapsible canoe and complete camp outfit. They were absent twelve days, and during the time covered a distance of over 4000 miles, a great part of it in territory absolutely unknown from a flying point of view. This trip, if undertaken by any other means available, would have required two seasons' travel.

In the course of a lengthy and, for the most part, highly technical paper, Mr. Alpheus Williams, the general manager of De Beers, gave a comprehensive survey of the diamond-bearing alluvial gravels of South Africa, both historically and geologically. He recalled the romantic and now world-famous story of the early diamond discoveries. Romance had, he said, always been associated with the development of the diamond-hunting industry in South Africa. The opening of the Lichtenburg area followed the discovery of a few diamonds by a road repairing party. In Little Namaqualand copper was mined laboriously before diamonds were thought of. The copper was taken by wagon to Alexander Bay for shipment overseas. Those pioneers of the copper industry actually lived, and probably travelled daily over an alluvial diamond area which, for its size, had proved to be the richest diamond deposit ever known—the Merensky deposit. It was an oyster that showed Dr. Merensky the way into a deposit from which millions of pounds worth of diamonds were obtained in a few months at very little cost. Mr. Williams quoted the story of the discovery as told by Dr. Merensky himself, and said Dr. Merensky and his party began their investigations with the benefit of all the work that had been carried out before they arrived. The men before them had done the pioneering and blazed the trail for the employment of the scientific knowledge which Dr. Merensky and his assistants happened to possess. Dr. Merensky and his assistant—Dr. Reuning—soon recognised that the gravel carrying diamonds contained shells and valves of a large fossil oyster, so that in a sense this particular oyster was an indication of diamonds.

Mr. Williams told of his travels in Namaqualand in 1927, when he saw the last camp of the late Mr. Fred C. Cornell, the celebrated prospector, at Zeudlings Drift on the Orange river. Cornell had worked on the alluvial gravels and was probably led away from the rich deposits at Alexandra Bay by the similarity of the Orange River Terrace gravels at Zeudlings Drift to those gravels he had known in other parts of the Union. At Zeudlings Drift, before his departure for England, Mr. Cornell erected two small washing machines. It was possible that he had found the right alluvial gravel and was on his way to raise capital.

While paying a handsome tribute to the work of such men as Cornell, however, Mr. Williams emphasised the part that scientific exploration must play in the discovery of diamond areas and scientific methods in their development. If Cornell did not discover the Alexandra Bay deposits, it was lack of scientific knowledge that drew him away from the place just as it was the possession of scientific knowledge which led Dr. Merensky and Dr. Reuning to the oyster shell diamond-bearing gravels at the mouth of the Orange River.

In the course of a comprehensive survey of the geological history of the alluvial diamond fields, Mr. Williams observed that the majority of those who argued against the theory that the Kimberlite formations were the original source from which the diamonds found in alluvial gravels were derived, had been unable to distinguish between gravels of most recent origin and gravels of very ancient origin. This difference, he went on, was of the greatest importance, because it was the ancient gravels that carried most of the diamonds. Their age alone explained why the diamonds found in any particular area did not always correspond in character to the diamonds found in Kimberlite pipes in the same area. That feature certainly did not prove that they were not derived from Kimberlite formations. The so-called difference in character between "river" stones and "mine" stones could not, with the information now available, be established; in fact, evidence is outstanding, that the majority of them are identical to the diamonds found in Kimberlite. Most alluvial gravels carry some diamonds which cannot be identified as being the product of any known mine, but their presence is easily explained as being diamonds derived from undiscovered Kimberlite occurrences.

The mineral position in the various provinces of Canada was dealt with in a series of papers. The remarkable development of the country as a producer of minerals, was the subject of a paper by Dr. Charles Camsell, B.Sc., LL.D., F.R.S.C., Deputy Minister of Mines for Canada. Until recently, he pointed out, the term "Granary of the Empire" correctly indicated the more important economic assets of the Dominions, but the mineral output of the country had risen from 64 million dollars in 1900 to 273 million dollars in 1928. Canada had secured practically complete control of the world's nickel markets, supplying 90 per cent. of their requirements. Canadian asbestos furnished about 85 per cent. of the world's demand,

THE LOCHABER HYDRO-ELECTRIC POWER UNDERTAKING

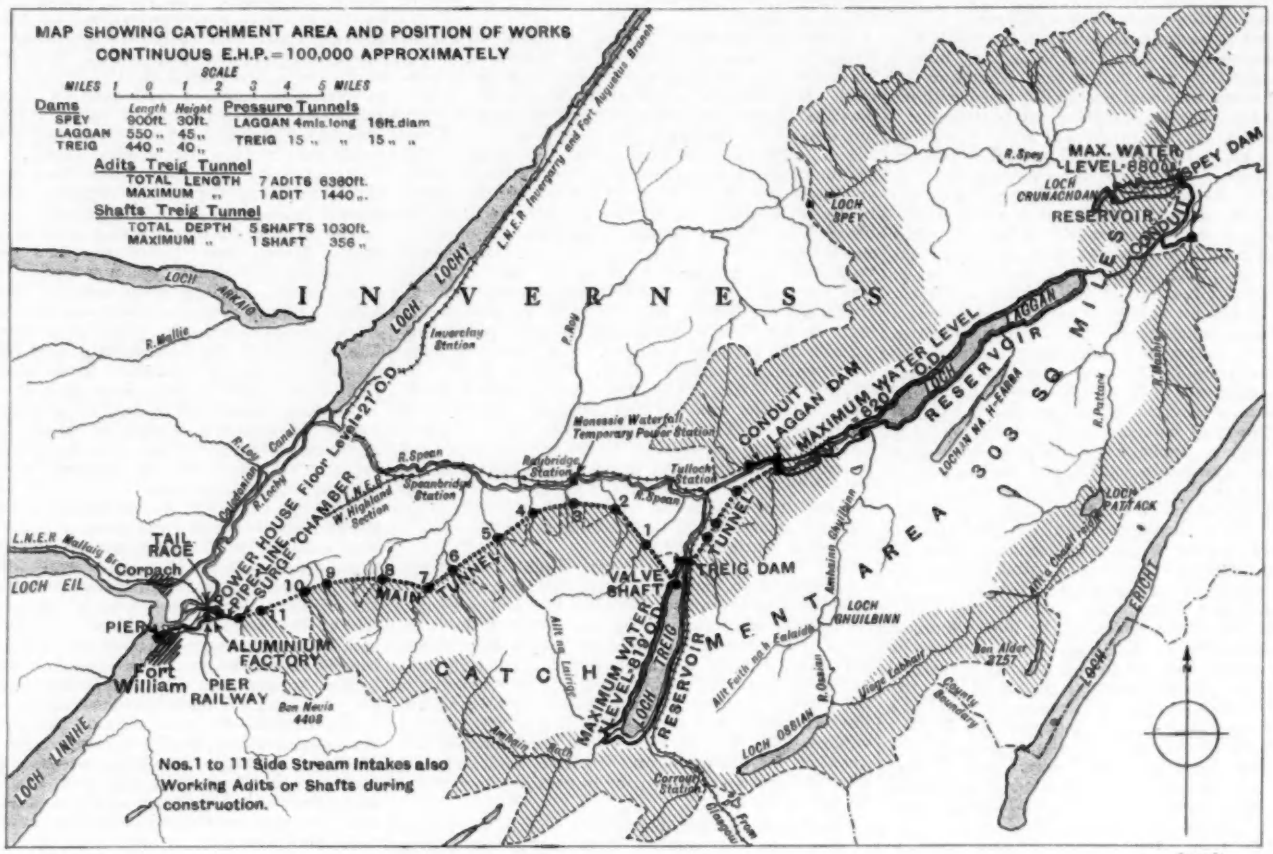


FIG. 1

and the Dominion might also be considered "the Industrial Mother of the metal cobalt." Canada has now reached third place among the gold-producing countries of the world; third place also in the production of silver, and fourth place in the production of lead and copper, while it also supplied a considerable part of the world's zinc. The annual value of Canada's gold output was maintained in the neighbourhood of 39 million dollars, but a very large increase in the output of gold from auriferous base metal mines was forecast, both through the expansion of operations now in progress and through the bringing into production of large new mines.

Vast areas of potential mineral interest still awaited the prospector. Meanwhile, a marked increase had been noted in recent years in the number of plants engaged in the manufacturing industries. In Canada, as in other progressive countries, the tendency was to force the product of the mine to yield the largest possible contribution to the national welfare and, as a consequence, the interdependence of the mining, metallurgical and chemical industries was becoming much greater than formerly. Modern chemical processes were turning into industrial channels materials wastefully consumed in the past. In Canada the most remarkable development along those lines was found in the processing of coals. That was also one of the major problems related to mining development now being investigated by the Dominion Department of Mines at Ottawa.

Mr. J. P. Messervey, Deputy Inspector of Mines at Halifax, attributed a sharp revival of gold mining in Nova Scotia during the past two years to new mining laws along modern lines which were passed in March, 1927. The new laws had not only revived the gold mining industry, but had also led to the opening of lead, zinc, copper and antimony deposits by powerful interests.

Reviewing the state of mining in British Columbia, Mr. John D. Galloway, the Provincial Mineralogist, stated that although the population had increased and the industrial life of the province had grown tremendously in the past 20 years, no more coal was being mined to-day than in 1910. It was, therefore, evident that the increased demand for heating and industrial power had been filled by oil fuels and hydro-electric energy. Much attention was, therefore, being given to displacing imported fuel oil with pulverised coal, and it was expected that this development would assist in reviving the coal industry. The application of modern scientific research, which had done so much for the copper mines, when fully applied to the problems of the coal industry, would undoubtedly bring it back to its rightful place in the economic life of the province.

Having completed their session at Cape Town, the delegates, after paying a visit to Kimberley, proceeded to Johannesburg to continue their meetings. There, most of the papers were taken as read, the authors merely briefly introducing them. Dr. A. J. Orenstein, C.M.G., gave a comprehensive review of the hygienic organisation of the gold mines, including prophylactic measures and the organisation of treatment, emphasising in the first place the importance of the selection for employment of only those men who were physically fit for the work to be performed. He described in detail the ration scale prescribed for native labourers, and said that since the introduction the incidence of scurvy had fallen to almost negligible proportions. Dealing with sanitation underground, Dr. Orenstein said that as the depth of mining and consequently the rock and air temperatures increased, the use of the enormous volumes of water prescribed by the regulations results in the saturation of the air, with a decrease of efficiency of the human machine and, particularly, proneness to respiratory infection. Here they were on the horns of a dilemma, and the solution was not yet in sight. If the water is decreased, the dust content of the air is increased; if the water is not decreased, work had to be carried out close to the critical point of human tolerance as far as work output was concerned, and the liability to respiratory infection—the more dangerous form of miners' phthisis—was increased, while the spread of hookworm was favoured. The question as to whether water really removed the dangerous minute dust before it was inspired by the workers also awaited an answer.

In a joint paper by Dr. L. G. Irvine and Dr. A. Mavrogordato, which dealt specially with miners' phthisis, the authors referred to the use of water for reducing dust. It had done so to a certain extent, but water had its limitations, and it had also positive disadvantages, both hygienic and economic. Hence the minds of engineers and medical men were turning to-day to the question, Have we been overdoing water? Could we not do better with less water and a greater extension of alternative methods? The recent visit of Dr. J. S. Haldane had stimulated much hard working in this direction.

Several highly technical papers dealing with temperatures and ventilation problems in deep mining were also presented.

The engineering trade unions have now received a reply from the Prime Minister to their request that an inquiry should be set up by the Government into the engineering industry. Mr. MacDonald has not accepted the proposal. The unions asked for an inquiry comparable in scope with those now being conducted into the iron and steel and cotton industries. Mr. MacDonald has replied that there are difficulties in the way, and suggests that the engineering trade union leaders should discuss the matter further with the permanent officials of the Ministry of Labour and the Board of Trade.

The Lochaber Hydro-Electric Power Undertaking.

No. I.

Introduction.

As we briefly announced at the time, the final blast which successfully removed the remaining barrier of rock separating Loch Treig from the inlet to the aqueduct tunnel for the Lochaber hydro-electric power undertaking was fired on January 3rd last. Thus the first portion of what will eventually be the most important undertaking of its kind in this country was completed.

It is difficult when writing of this most interesting scheme to avoid using superlatives, for both in its conception and in its execution it is an engineering work of outstanding merit. We have on several occasions, notably in our issues of March 4th, 1921, and July 6th, 1928, published illustrated accounts of the work. The first article appeared before the scheme had received parliamentary sanction; the second when the work was well on the way to completion. Both articles entered into considerable detail, but, in order to make the present article complete in itself, we propose to repeat a good deal of what we said on those two dates.

The scheme was originated by Mr. W. Murray Morrison, M. Inst. C.E., M.I.E.E., a director and the general manager of the British Aluminium Company, Ltd., and the Private Bill which resulted in the Lochaber Water Power Act, 1921, sanctioning the construction of the works was promoted by the directors of that company. The works are being carried out on behalf of the Lochaber Water Power Company by the North British Aluminium Company, Ltd., the latter being a subsidiary company of the British Aluminium Company. The main object of the undertaking is to produce electrical energy for the production of aluminium.

The working out of the project at the outset was in the hands of the late Mr. C. S. Meik, of the firm of Messrs. C. S. Meik and Buchanan—afterwards C. S. Meik and Halcrow—who prepared the scheme with which to back up the application for parliamentary powers. So carefully did Mr. Meik elaborate his proposals that the scheme, so far as it has been completed up to the present, has been carried out largely as it was originally planned. Unhappily, Mr. Meik did not live to see the completion of the work, for he died in 1923 and the whole of the carrying out of the work devolved upon his partner, Mr. W. T. Halcrow, M. Inst. C.E. It is to him that we are indebted for an opportunity of visiting, and of making a thorough inspection, of various portions of the works, and we would take this opportunity of thanking him for that and for the help he has so courteously

extended to us during the preparation of the following article. We would also congratulate him on the success which has attended the operations which he has developed and superintended.

GENERAL DESCRIPTION OF THE SCHEME.

Before going on to describe in some detail that portion of the works which is now completed, it would be well, perhaps, to give a general outline of the scheme as a whole. In order to help our readers the better to understand our explanation, we reproduce in Fig. 1 a map which was published with our article on July 6th, 1928, on the occasion of a Summer Meeting in Scotland of the Institution of Electrical Engineers, when the visitors had an opportunity at the invitation of the British Aluminium Company of inspecting the works then in progress. We also give in Fig. 2 a diagrammatic profile of the whole scheme. The watershed, the run-off from which the company, under its Act, obtained powers to control, encloses an area of no less than 303 square miles. According to Dr. Hugh Mill, who specially investigated the matter on behalf of the British Aluminium Company, Ltd., the maximum rainfall in any part of the district may reach to as high a figure as 160in. per annum, while an average annual rainfall of as much as 78in. may be expected over by far the greater portion of that area. The mean equivalent run-off to be anticipated is, we understand, 66in. per annum, and that, without further deductions, would mean an average of nearly 800,000,000 gallons per day. In the calculations to ascertain the actual net amount of power available, however, a deduction of 30 per cent. has been made from the 66in. in the case of a comparatively small area over which the rainfall is not so heavy as it is in the rest of the gathering ground. By way of comparison, it may be explained that the standard daily average natural flow of the Thames at Teddington is 1357·2 million gallons, but that, at times, the flow may be as low as 150 million gallons and as high as over 10,000 million gallons a day. The rivers and streams which will provide the water for the Lochaber scheme are, similarly, subject to wide variations in flow, so that a considerable volume of storage was a necessity. It so happens that Nature has provided in Lochs Laggan and Treig a large proportion of the requisite storage. Loch Laggan is a sheet of water some 7 miles long with a width varying from a quarter to five-eighths of a mile. Seven miles or so from its lower end lies Loch Treig, which is some 5 miles long and five-eighths of a mile wide in its widest part. Both are deep lochs, the maximum depth of Loch Treig being some 436ft. At its lowest point, in times of scanty rainfall, the top water level of Loch Laggan stands at 818ft. above Ordnance Datum and by dredging the outlet it is intended to draw it down to 804ft. It is a great pity from the point of view of the scheme we are discussing, that the Loch does not stand at a good deal higher level than it does, for then its contents could have been drawn upon to a much greater extent than it actually will be. However, in times of heavy rainfall, the surface level rises to 820ft. O.D. and the proposal is to keep it normally at that level, by forming a dam, not actually at its westward, or discharge, end, but at a point some 3¼ miles as the crow flies downstream on the River Spean, which drains the loch into the River Lochy, which, in its turn, discharges into Loch Linnhe, an arm of the sea. The effect of building this dam, which is to be 550ft. long and 42ft. high, will be to form an additional reservoir, to be known as the Spean reservoir, the waters of which will join up with those of Loch Laggan. Hence there will be available for drawing off for the purposes of the undertaking a depth of 16ft. of water from the combined areas of Loch Laggan and the Spean reservoir, which will amount to some 2440 acres.

Loch Treig has a normal level at the present time of 783ft. above O.D. It is proposed, however, eventually to raise that level to 819ft. above O.D., or 1ft. below the top level of Loch Laggan and the Spean reservoir, by the construction of a dam at the northern or discharge end of the loch. It is further proposed to connect the westward end of the Spean reservoir with the northern end of Loch Treig by means of a tunnel 16ft. in diameter, so that the water from Loch Laggan and the new reservoir would find its way by gravity into Loch Treig. This tunnel, which will be rather more than 3¾ miles long, will have a fall of 41ft., so that the full amount of water in the loch and reservoir down to 804 O.D. will be able to flow into Loch Treig. On the site of the Loch Treig dam boring operations have for some time been in progress to ascertain the nature of the ground and the depth at which solid rock may be expected.

In addition to the foregoing, there are further sources from which water is to be obtained. The River Spey flows eastwards through Inverness-shire and discharges into the Moray Firth and the North Sea. It was a somewhat daring suggestion, therefore, that some of its water should be diverted so that it should flow westward into the Atlantic Ocean. Yet the proposal was made and it received sanction. A determining factor in its being passed was, probably, that, in its upper reaches, the Spey is very subject to flooding and the riparian owners were not averse from a scheme which would so regulate the flow of the river during times of heavy rain that flooding would be done away with. The sanction was, however, subject to the proviso that there should be no abstraction of water when the flow of the river dropped below normal.

It is proposed to build a weir 900ft. long and 30ft. high across the Spey just below its confluence with the Markie Burn and about 2 miles to the westward of Laggan Bridge in Inverness-shire. The effect of the weir will be to raise the level of the Spey at that point, during floods, by some 30ft., with the result that a reservoir nearly 2 miles long and just under half a mile wide at its widest part will be formed, the reservoir reaching to, and being connected with, Loch Crunachdan. The crest level of the Spey weir is to be at 880ft. above O.D., and in times of flood only the normal flow of the river, which is taken as being 40 million gallons a day, will be allowed to pass downstream, the surplus being diverted into a conduit nearly 3 miles in length, and having a general direction a little west of south, to make junction with the Pattack near the point where that river turns westward to discharge into Loch Laggan.

Another stream, the Mashie, flows northwards to make confluence with the Spey about midway between the site of the proposed weir and Laggan Bridge. Its discharge, in times of heavy rains, helps to accentuate the flooding in the upper valley of the Spey. Hence it was natural that the request to abstract a portion of its flow, at times when that flow exceeded a certain volume, should be granted. The declivity of this stream is such that it is possible to form an intake on it at such an elevation that a proportion of its water might be diverted into the conduit leading from the Spey reservoir to the River Pattack. By these arrangements some of the waters of the Spey, the Markie Burn and the Mashie, will be prevented from flowing into the North Sea and will be discharged into the Atlantic Ocean by way of the Lochaber power-house.

Nor are the foregoing quite all the additional sources from which supplies of water are to be obtained in this portion of the undertaking. There are four others. By forming an intake at a sufficient elevation on a small stream—the Allt a'Chaoruinn—which normally discharges into the River Spean at a point downstream of the site chosen for the Spean dam, it will be possible to divert its flow by means of a conduit into the reservoir. Then, again, at three points in the length of the tunnel connecting that reservoir with Loch Treig it is proposed to form dams across three small streams so that their flows may be intercepted and delivered into the tunnel by means of shafts.

It will be realised that every drop of water which can be diverted into Loch Treig is of value, for the lower point to which the loch can be drawn down is at 695ft. above O.D. and a gallon of water per minute falling through that height represents over one-fifth of a horse-power.

In the foregoing we have dealt only with that portion of the authorised scheme of 1921 which is to be carried out in the future, but which is likely to be revised in certain respects. It was thought best to take that course in order, first of all, to give our readers some idea of the far-reaching character of the undertaking—the Spey weir, it may be remarked in passing, will be some 37 miles from the power-house at Fort William—and also to help them to appreciate the care which has been devoted to working out its details and to taking advantage of every possible chance of leading water from all parts of the gathering ground into useful channels. It was, moreover, deemed of interest to trace the flow of the water from the highest level—the 880ft. above O.D. crest of the Spey weir—down as far as Loch Treig, a distance of 20 miles or so. We can now proceed to describe what has actually been done up to the present time.

(To be continued.)

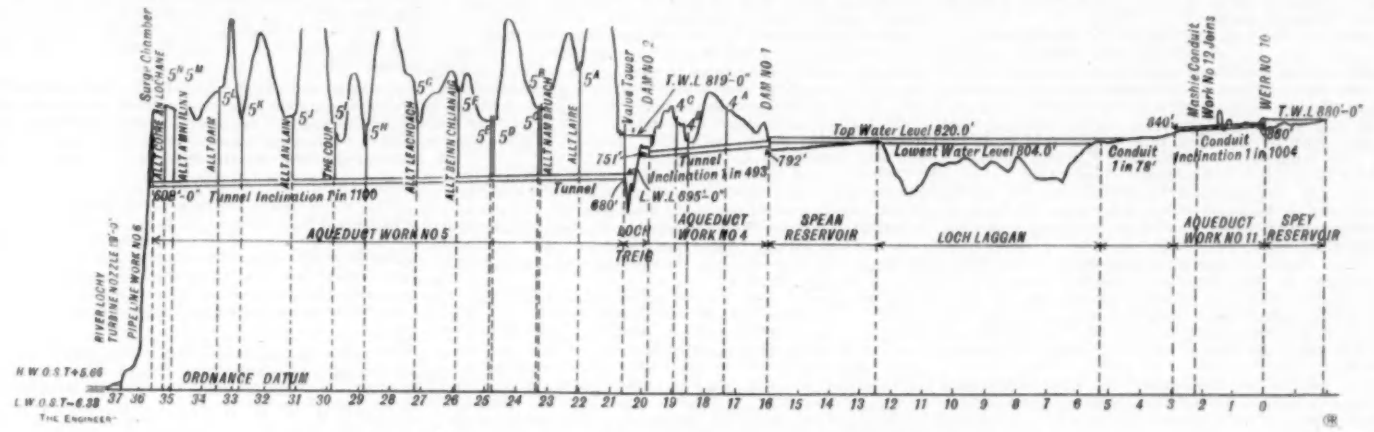


FIG. 2—DIAGRAMMATIC PROFILE OF THE LOCHABER POWER SCHEME

The Work and Influence of the Engineer.*

By R. E. FLANDERS.

WE have been looking forward for many months to this fiftieth anniversary of our Society. It has appealed to the imagination in many ways. In the first place, it is a family affair of our members, in the course of which we gather to review the past, rejoice in the present, and pledge our mutual co-operation for the future.

Beyond this, we have looked forward with eagerness to the privilege of meeting and making ourselves acquainted with our friends of sister professions and from sister nations. We had hoped for, and have not failed of, a human intercourse of a most satisfying and valuable sort.

Above all, it had seemed to us that we might attain in this intercourse to something of still higher worth. We are blessed here in Washington this week, and particularly in this room to-night, with an assemblage of acknowledged leaders in the engineering fraternity, honoured alike by their own national societies and by world-wide professional recognition. Such, gentlemen, you are; and being such, your presence here to-night offers a unique opportunity for us to talk over, in an informal way, some of the problems which affect the welfare of human beings in our times—problems for which engineers have a responsibility, and for whose solution they should hold the keys.

In this country there has been a recent, widespread and deep interest in the engineer. For a hundred years, in our applications of pure science and in our contributions to the practical sciences, we have been the active agent in the transformation of society. The pure scientist and the unscientific inventor have long been in the public eye. Only in the past year or so, awakened perhaps by the elevation of Mr. Hoover to the Presidency, has our profession come into the floodlight of public interest.

In newspapers and magazine articles and in books the engineer is being described and analysed, his work evaluated and his possibilities predicted. At this moment in America he is the centre of attraction in the minds of thoughtful people. The criticism is for the most part friendly. There is a general feeling that he should be allowed a wider range of influence in the social organisation. And—the hopes based upon his past record and present performance are uncomfortably high. It is this general subject of the engineer in his social relations and possibilities that I am privileged, by the grace of my associates, to discuss with you to-night.

Engineering, and industry based upon it, have bestowed at least one unquestioned and priceless gift on humanity. This is the gift of magnificent productivity.

In simpler days, not many centuries back in time nor many thousand miles away in space, the individual man, assisted by his family group, by continuous and concentrated toil could do little more in the twelve months than provide the bare necessities of food, clothing, and shelter. Broadly speaking, if *A* was rich, it was at the expense of *B* and *C* and *D*, who were each pushed a step nearer to impoverishment by the demands of *A*. The raising of a lordly building or the defence of the realm from external violence directly and indirectly impoverished its thousands. Accumulation at one point meant beggary at another.

When in the due process of history the engineer arrived,

* Address delivered at the Jubilee Celebrations of the American Society of Mechanical Engineers, Washington, April, 1930.

his work quite changed the scheme of things. By scientific design, construction and management of the implements of production and distribution, he increased the productivity of the individual man, ten, fifty, and sometimes a hundred fold. Of that hundred fold he may, if fortunate, get seven fold for himself. *A*, the skilful accumulator of wealth, may get ninety fold, but *B*, *C*, or *D* at least get three fold. There may be no equity discernible in the distribution. But the engineer's efforts have resulted in harm to no one, at least some slight benefit to everyone, and the possibility—for the first time—of plenty for all.

The provision of an adequate surplus of food, clothes, the materials of shelter and innumerable other material goods, is the unquestioned achievement of the engineer.

With proper distribution—not yet attained—this surplus is capable of yielding desirable things, or fruitful leisure, or some of both, to every member of a properly balanced industrial society.

To the extent that this surplus is wisely distributed—and every year sees an advance in this respect—human relations take on a new and more friendly aspect. When it is seen that engineering skill and co-operative effort are more effective in the accumulation of wealth, than are robbery and social disorganisation, under whatever legal mask they may be concealed, then is the world ready for that "new kindliness" which Dean Kimball assures us is already in evidence in American industrial life.

To the pure moralist, this "new kindliness" based on improvement in material things may seem to be non-moral or unmoral, being arrived at too easily; but, as we are assured by that brilliant English clergyman, Dean Inge, there are many arrangements of the Deity which perplex the man who is a moralist and nothing more.

The engineer, then, has provided the surplus, and with it the partly realised possibilities of general plenty and leisure, with a corresponding improvement in the relations of man to man. He has, in addition, certain qualities to contribute.

One of them is *hard-headedness*. He is not accustomed to flying off on unproved theories. Everything he touches his hand to is required to work. His failures are few, and, for the most part, unimportant. There is a certain definiteness about his methods which is sadly lacking, for instance, in those new sciences, sociology and psychology. For these sciences wide but unsupported claims have been made which have aroused vain hopes in our minds in times past. The engineer, even though his field is narrow, is a far safer guide on the road of social progress.

The engineer, finally, is *quality-minded*, without losing the benefits of his special forte of quantity production. The product which has had prolonged and intense engineering attention is almost sure to be a quality product. This is noticeably true of those which have been subjected to *engineering* standardisation. Such standardisation is a grading upwards, not downwards; and its prospective extension into the equipment and materials of the ordinary household will be an unalloyed blessing.

The problem before us is to determine how best to apply these material goods and personal qualities of the engineer to the problem of social progress. I am sure that our guests from foreign lands will pardon us if we discuss the matter primarily from the American standpoint, with which, of course, we are most familiar. I have not failed to give thought to the European situation also, and some aspects of it appear clear. But, in general, lack of close familiarity makes it unwise to wander far afield.

Pardon is likewise asked for the very condensed and rapid survey which is required by the shortness of our time and the breadth of the subject.

The object of our inquiry is the attainment by the average inhabitant of the modern civilised state of what we may call the *Good Life*. I am going without further apology to attempt a definition of that somewhat debatable term.

The *Good Life*, in general, is one characterised by enduring *satisfactions*, rather than by transient and changing flashes of pleasure.

One of its prime elements is *functional satisfaction*—the deep sense of well-being which fills us as we successfully exercise the organs, the instincts, the faculties—inborn and acquired—and the store of experience which all combine to make up the individual personality.

This functional satisfaction may be drawn from the daily work—from the trade or the profession, the research of the scientist or the managerial efficiency of the industrial leader.

Functional satisfaction can be found in hobbies as well; likewise in recreation—gardening, playing bridge or sailing a boat. Anything which permits the acquirement and exercise of skill will serve. In many people this outside interest is so strongly developed that they are content with a monotonous and uninspiring occupation if it gives them the needed money and leisure for their real interests.

The consciousness of *enlargement of the personality* is another element of the Good Life. In a sense it is the dynamic form of the more static functional satisfaction. The increased acquaintanceship with books, travel, the widening of acquaintance, the elaboration and deepening of all contacts with life, serve this elementary need.

Most of us cannot do without some measure of *objective achievement*. To see the hidden idea, the faculty, the personal growth expressed in material form is to intensify their value to us. The slowly built and lovingly tended garden, the finished technical paper, the selected and cultivated group of friends, the close-knit business organisation, the adopted social policy—all these concrete embodiments of immaterial forces put the crowning touch on days of patient concentration.

This element is weakened under modern conditions for the ordinary worker by the rarity of his contact with the finished work to which he is contributing. Special provision for this contact would greatly increase his satisfaction.

Social integration is a deep-seated human need. Family love, love between the sexes, friendship, the bonds of social, professional and political organisation—all those ties by which one lends his strength to many, and the many support the one, are necessary to the fully rounded life.

Last in the ascending series and most difficult of attainment is the sense of *cosmic integration*—the assurance of a place in an ordered universe.

To provide this place is the function of religion and philosophy. It was the difficulty of retaining this deepest and most serene of the satisfactions in the face of the accumulated knowledge of the centuries from the 15th to the 19th, that accounts for the spiritual hunger of the last generation. The sudden expansion of physical knowledge in our new century—sudden to the point of explosion—is happily bearing fruit in a clearer cosmic viewpoint. I will refer to this later.

Among the durable satisfactions I have not mentioned that of *recognition*—the appreciation and approbation of our fellows. This may be very solid and real, but only if it is not consciously sought for. Those of us who have critically considered our lives for any extended time will assign a doubtful value to this desire for recognition. If it comes unexpectedly and unsought, well and good. But for the most part it is a devouring appetite rather than a durable satisfaction.

All the good things outlined above, in their varying degrees and kinds, may be enjoyed by all sorts and conditions of men in their appropriate ways.

Let us next proceed to consider some concrete material factors whose provision lies within the province of the engineer, which will minister to the durable satisfactions. Let it be understood that in the brevity of our discussion the connection will not always be made explicit. And let it be further understood that society cannot *guarantee* the satisfaction of the individual. It can only provide him with favourable conditions.

One condition that engineering progress provides has already been mentioned—leisure and material plenty for all are now *physically* possible. This possibility is not an actuality is due to social maladjustments which must be remedied—in part by further social and economic research and in part by the self-imposed discipline of the individual. Of this also more later.

As an allied factor, *stability of employment* is a possibility. No engineer would be satisfied with a "hunting governor" on a 100,000 kW steam turbine and generator tied into a widely ramifying super-power circuit. Yet the term "hunting governor" does not begin to describe the faults of that formerly much-praised regulator of industry and commerce, the speculative stock market. Besides the faults of the governor there are the added disturbances of buying or selling movements equivalent to the penstock surge in a hydraulic turbine, and to the sudden increase in pressure when the governor closes the gates. Some small variation of flow is needed to set the regulative mechanism in action. But too much is too much. Our clumsy, insane financial governor demands research and redesign from the engineering viewpoint.

Besides the steadiness of operation which assures steadiness of employment, the mass of the population should find some relief from the deadening fear of sickness and old age for which no financial provision can be made. Sickness may be partly avoided by that admirable development of preventive medicine which so closely parallels the work of the engineer. But some degree of sickness will always be with us, and none can escape old age save by premature death.

Many of you have read "Middletown," that detailed, monotonous, occasionally interesting, usually drab, but always significant survey of a medium-sized industrial city in our middle west. If you have read "Middletown," you will not soon escape from the impression of impending disaster always hanging over the working population from the triple menace of unemployment, sickness and old age. The antidote for that menace lies in the surplus which engineering stands ready to provide. And that surplus can always be increased when we are ready to abandon wasteful competition, extravagant salesmanship and inefficient management. But we have not yet solved the problem of applying the surplus to afford the required relief in a socially desirable way.

As a specific picture of general improvement (one only of many possible ones) imagine the dirty, crowded, flimsy quarters of Middletown's working population destroyed. In their place build a network of cement highways radiating into the surrounding country, and sprinkle along it desirable houses or groups of houses set in garden plots of one-half to five acres. All homes would have their vegetable gardens. Many would have poultry. Some few would have a cow or two. An amphibious society like this, living partly in industry and partly on the land, would have greater stability and be within closer reach of the enduring values than is now possible to them. Better equipment and management can shorten the working hours to permit the day or two of farm work per week. And engineering builds the concrete roads, the autos, the school buses, the telephones and the radios which destroy the demon of isolation.

It would be folly to attempt to design a completely safe and automatic social mechanism. We would not if we could. It would destroy important human satisfactions to relieve man of all his responsibilities. Such safety would be purchased at too high a price. To a great degree each man wants to be the architect of his own fortunes.

Nor would we destroy the privilege of offering and accepting neighbourly kindness. When this is no longer necessary something worth while will have gone out of life. It would do violence to the value of social integrations. When there is no substratum of social injustice to sour the soul, these friendly offices can be received as freely and gladly as they are offered.

Life, on the whole, has been easy for us here in America. We are not more virtuous or more intelligent than the other races of the earth. But we have had a continental area to develop—rich in almost every raw material required by modern industry; and our isolation has permitted us to concentrate habitually on peaceful activities. Along with some small virtues which we will modestly forbear to mention, these conditions have produced an unparalleled expansion of wealth which has descended, however scantily, further down the social scale than in any other place or period recorded in history.

The mechanism of this prosperity has one weak link. It has been geared to a constantly increasing tempo of production, based in turn on increasing population, increasing development of natural resources, and an apparently limitless proliferation of science and invention. We have been prosperous during periods of rapid growth. Not stoppage, but a mere slowing in the rate of expansion has been enough to break down the mechanism of production, distribution and finance. The machinery was not designed for a flow at a continuous rate and cannot be so used, apparently, without radical changes.

This is a real weakness, for it seems sure that an increasing rate of expansion cannot be a permanent condition. By birth control and restriction of immigration we are keeping the growth of population within limits. We have already seen the advisability of replacing exploitation of resources by conservation, and are beginning to practice it. What about the continued proliferation of invention? The bicycle, the motor car, the tractor, motorised household equipment, the radio, the airplane—then what?—and then what?—and then what?

It is true that there have been many false alarms of a slow up in material progress. As early as the closing decade of the seventeenth century the Frenchman Charles Perrault wrote:

> "Our age has in some sort arrived at summit of perfection. And since for some years the rate of progress is much slower and appears almost insensible—as the days seem to cease lengthening when the solstice is near—it is pleasant to think that probably there are not many things for which we need envy the future generations."

This seems amusing and incredible. But I am told that a director of our own patent office, some time in the 1850's, resigned his position because it had no future. All the possible inventions of importance had already been made.

But listen to our own Dr. Milliken, writing in Scribner's Magazine for February of this year:

> "It is difficult to see how the future can have any other period of such rapid change in store.
>
> "In the way he conducted his daily life my grandfather is indubitably more remote from me than he was from the earliest man mentioned in recorded history—In many fields no past time has known and no future time can know so sudden and so complete a transformation."

What shall we say to all this, when prophecy has so often been disconcerted by the facts? We can only say that some time, when we know not, the prophecy will come true—at least for a time.

There are rhythms in Nature—systole and diastole of the heart—inhalation and exhalation of the breath—high tide and low—day and night—summer and winter—and the larger rhythms of the glacial periods and the geologic eons. Shall not our scientific and engineering efflorescence have its period also?

We might well pray for a change. In our industrial development we have been as though living in the mad rush of a pioneer period. Year by year we have crossed the rivers and the ranges, hastily scratched the soil with our ploughs, raised our scanty crops, and moved on. The time has come to occupy the land, to subject it to high cultivation, to plant the vine and the fig tree, and to build stately mansions.

There will be no definite, clear cut line of division ending the pioneer period and inaugurating that of occupation and development. New territory, large and small, will be opened up from time to time. But there is much reason to believe that we have already come to the turning point in industry and invention, and that from now on the men of keenest intelligence and widest experience will find that the work worthy of their abilities lies in the neglected field of social organisation and control.

The time has come, then, to apply the engineering viewpoint to the social machine—to improve its efficiency, its durability and the excellence of its product. In urging this we are not uttering solitary cries in the wilderness or speaking into deaf ears. The way is being made ready.

There is, for example, that new interest in the engineer and his way of working, already mentioned. The idea that his methods can be socially applied has caught the popular imagination.

Then there is that idea of "service," much ridiculed, but conveying a basic truth. In the primitive "starvation economy," described earlier, when *A* bargained with *B*, the margin of profit was small and one of the two was almost certainly a loser. Under modern "surplus economy," as derived from the work of the engineer, the normal business transaction results in unquestioned advantage to both parties. There may be jockeying over a division of the profits, but some part will go to each. This simple fact has completely changed the atmosphere of modern business. It is full of the oxygen of mutual confidence and respect. It furnishes ready-made the ideal background for the coming change. The "new kindliness" is one of its overt manifestations.

Another of the straws in the wind is the progressive refinement in the practice of philanthrophy. The stages are clearly visible. Fifty years ago a wealthy man would provide in his will for a public drinking fountain and horse trough in the town square, adorned with a marble statue of himself, mutton chop whiskers, congress boots and all. The next ascending stage was the endowment of a self-named institution—library, hospital or college. Next came the occasional case of the anonymous donor, often of large gifts; and, paralleling that, the instituting of foundations for social purposes in which the money gift is only one element, the balance being the careful and yet bold exercise of organising ability and business direction—gifts of greater value than those measured in dollars.

And last in the series there is that still rare but occasional philanthropist who expresses himself in an integral, organic benevolence. The principal concern of such a man is to so order his affairs that "*the very earning of his money is itself a social service*, irrespective of the use he later makes of it. So far as our present vision goes, the biggest social service the individual can render is to engage in the manufacture and distribution of goods which are useful, or beautiful, or both; and so to do this as to give secure, remunerative employment to the largest possible number of people, under working conditions which give full opportunity to ability and satisfy the requirements of human dignity and self-respect."

The important elements in this new viewpoint of industrial life are, indeed, only a generation old.

That last and deepest value—cosmic integration—has waited on the work of such men as Einstein, Eddington and Milliken. The farthest and deepest reaches of mathematics, physics and galactic astronomy were necessary for its formulation.

It is being seen and described and analysed by such men as Professor Whitehead, whom Harvard has borrowed from Cambridge University to fill her chair of philosophy.

After pages of metaphysics, as modern as the radio

but as deep as the universe, in the midst of which he flows over and around and past such minor problems as the freedom of the human will and the difficulties of the relationships of mind and matter—floating these things off as light and empty wreckage on the full tide of his argument—after pages and chapters of subtle reasoning, he breaks out in paragraphs like these :—

"The watchwords of the nineteenth century have been, struggle for existence, competition, class warfare, commercial antagonism between nations, military warfare. The struggle for existence has been construed into the gospel of hate. The full conclusion to be drawn from a philosophy of evolution is fortunately of a more balanced character. Successful organisms modify their environment. Those organisms are successful which modify their environments so as to assist each other.

"The point is that professionalism has now been mated with progress. The world is now faced with a self-evolving system which it cannot stop. There are dangers and advantages in this situation. It is obvious that the gain in material power affords opportunity for social betterment. If mankind can rise to the occasion, there lies in front a golden age of beneficent creativeness. But material power in itself is ethically neutral. It can equally well work in the wrong direction. The problem is not how to produce great men, but how to produce great societies.

"But, in this sense, art concerns more than sunsets. A factory, with its machinery, its community of operatives, its social service to the general population, its dependence upon organising and designing genius, its potentialities as a source of wealth to the holders of its stock is an organism exhibiting a variety of vivid values. What we want to train is the habit of apprehending such an organism in its completeness."

I have never undergone the discipline of philosophy in the schools, so his basic metaphysics is only dimly understood. But these disconnected paragraphs, inadequate though they seem apart from their context, are scattered fragments from the message of a prophet who is already walking ahead of us into the new age, pointing out the way and reporting on the grandeur and beauty of its aspects. That new age is one of human rather than material development.

We have reached indeed a fortunate and thrilling moment in the flow of history. One civilisation after another has been born, grown, matured, and met defeat at this crisis we now face. In past times, whenever the automatic, naturally evolved safeguards of traditional religion and old customs have dissolved under the spell of increasing critical judgment, so that men were required to govern their social relations directly by their own intelligence and goodwill, hitherto they have always failed.

Now we come to the same narrow pass, but with clearer guidance. Thanks to the scientist and the engineer, we have adapted ourselves to natural laws, and for the first time control our material conditions. We are blessed also with the historical sense, which puts our own cycle into its place in the long perspective, and warns us that the zero hour approaches. We live in the kindlier human atmosphere, born of the new economy of the surplus. And lastly, with generations of a religion of goodwill behind us, we are armed with that mighty and indispensable weapon for the conflict that is ahead.

We face the greatest event in human history—and we will not fail.

Water Power in the Pulp and Paper Industry of Canada.

THE relationship between the pulp and paper and the water power industries of Canada is a most intimate one, and one of great importance to the industrial and economic structure of the Dominion, in that each industry makes a most substantial contribution to the success of the other. The extent of this contribution may be gauged when it is stated that the pulp and paper industry relies almost entirely upon water power for its energy requirements, whilst over 28 per cent. of the hydraulic turbine installation in Canada is required to supply the power necessary for the manufacture of pulp and paper.

The pulp and paper industry is Canada's greatest manufacturing industry, its gross and net values of production 219,329,735 dollars and 134,516,073 dollars respectively in 1928, and its disbursements for salaries and wages 45,674,293 dollars, being greater than for any of the other manufacturing industries. In fact, Canada has of recent years taken the leadership in the manufacture of newsprint paper, her output of 2,082,830 tons, valued at 132,286,729 dollars, for the calendar year 1927 being 600,000 tons in excess of that of the United States, the second producing country, while her export of this commodity, 1,881,685 tons, contributed 129,637,687 dollars to the country's favourable trade balance, and exceeded the combined newsprint export of all other countries.

The continuous operation of mills in the pulp and paper industry, usually twenty-four hours a day, lends itself to the securing of a very low unit cost of power where the power is derived from water, since the main item in this cost is the interest on the capital invested in the hydraulic development, which remains constant whether the plant operates ten hours a day or twenty-four. Whereas, in the case of fuel power, the higher cost factors of operation and fuel are directly affected by the length of the daily period of operation. Also, in mills using hydro-electric power, the development of the electric steam generator has provided additional economies, as any available surplus or off-peak power may be utilised for producing steam for pulp cooking, heating, and similar uses.

The water power installation of the pulp and paper mills utilising hydraulic or hydro-electric power aggregated 565,326 horse-power in the beginning of 1929, of which 283,343 horse-power was directly connected to pulp and paper machines, and 282,343 horse-power to electric generators. In addition to that, there are large turbine installations in central station plants producing the power sold to pulp and paper mills. A careful analysis of the figures for this power, sold both on the horse-power year and the kilowatt-hour basis, indicates that the turbine installation must be virtually equal to the aggregate installation of the motors which utilise this power, namely, 789,530 horse-power.

Thus it is seen that the turbine installation supplying power to pulp and paper mills in Canada aggregated in the beginning of 1929, in round figures, 1,355,000 horse-power, of which 1,071,873 horse-power was hydro-electric and the remainder direct hydro drive. The use of steam as a source of power for the pulp and paper industry in the Dominion is very limited, the total installation amounting to only 120,352 H.P., or 8·2 per cent. of the total power installation and being usually prompted by special conditions, such as operation in close connection with the manufacture of lumber, when refuse from the latter can be used as fuel under the boilers. There is also some slight use of internal combustion engines.

The Province of Quebec, with the largest pulp and paper output among the nine provinces of the Dominion, has fifteen pulp mills, twenty-three pulp and paper mills, and fifteen mills devoted exclusively to the production of paper. Thirteen of the pulp mills, thirteen of the pulp and paper mills, and eleven of the paper mills operate their own hydraulic developments, and maintain an aggregate installation of 215,736 horse-power, of which 145,296 horse-power is direct connected to the mill machinery and 70,440 horse-power to electric generators. The mills purchasing all or part of their power, twenty-eight in number, maintain a motor installation driven by purchased power of 566,371 horse-power.

Outstanding mill organisations in the Province of Quebec producing their own power are those of Price Brothers and Co., Ltd., operating a pulp mill at Beau-sejour, where 3150 H.P. is installed on the Rimouski River, and pulp and paper mills at Jonquiere and Kenogami, where four developments have a combined installation of 59,300 H.P. This company also purchases almost the entire output of the 10,800 H.P. plant of the Shipshaw Power Company. Price Brothers and Co. also operates a third very large pulp and paper mill at Riverbend—see Fig. 1, page 462—the power for which is secured from the Isle Maligne plant of the Duke-Price Power Company on the Saguenay River. The Quebec Pulp and Paper Company, Ltd., operates two large pulp mills, one at Chicoutimi, where 20,220 H.P. is installed in two plants on the Chicoutimi River and one at Val Jalbert, with an installation of 7300 H.P. on the Ouiatchouaniche River.

The Canada Power and Paper Corporation, operating pulp and paper mills at Shawinigan Falls, Windsor Mills, Grand'Mere and Three Rivers, has an installation of 17,910 horse-power on the St. Maurice River, using water drawn from the headworks of the Shawinigan Water and Power Company for the operation of its Shawinigan Falls mill. This company also purchases power from the Shawinigan Water and Power Company to operate its Three River mill and to supplement the power at its Shawinigan Falls mill. Power to operate its Grand'Mere mill is secured from the Laurentide Power Company—see Fig. 2, page 462.

The Canadian International Paper Company purchases the power for the operation of its Gatineau mill from the large Gatineau River hydro-electric developments of a subsidiary, the Gatineau Power Company. Power for the operation of its Three Rivers mill—see Fig. 3, page 462—is obtained from the Shawinigan Water and Power Company, while its mill at Kipawa, which specialises in a high-grade of rayon cellulose, receives its power from the Gatineau Power Company's 25,050 H.P. plant on Gordon Creek.

DEVELOPMENTS IN ONTARIO.

The Province of Ontario has twelve pulp mills, seventeen pulp and paper mills and eighteen paper mills with a combined installation of 238,880 H.P., over 60 per cent. of which is connected to electric generators. Twenty-eight of the mills purchase all or part of their power and have a motor installation of 185,472 H.P. driven by purchased power.

Outstanding among the pulp and paper organisations in Ontario may be mentioned the Abitibi Power and Paper Company, Ltd., which has a pulp mill at Smooth Rock Falls and pulp and paper mills at Iroquois Falls, Fort William, Sault Ste. Marie, Espanola and Sturgeon Falls. In connection with the Smooth Rock Falls mill, the company has a 9350 H.P. installation on the Mattagami River; the Iroquois Falls mill is furnished with power from two plants at Iroquois Falls and Twin Falls on the Abitibi River, with an aggregate installation of 58,000 H.P., supplemented by power purchased from the 48,000 H.P. plant at Island Falls on the same river owned by a subsidiary, the Abitibi Electrical Development Company. The Sault Ste. Marie mill has a 14,400 H.P. installation on the St. Mary's River and purchases additional power from the Great Lakes Power Company. The Espanola mill—see Fig. 4, page 462—has a 20,800 H.P. development on the Spanish River and also secures power by purchase from the plants of the International Nickel Company on the same river; whilst the Sturgeon Falls mill is operated by power from two plants on the Sturgeon River. The Fort William mill is operated entirely by purchased power. The Abitibi Company's turbine installations aggregate 174,340 H.P., of which 107,450 H.P. is connected to electric generators.

The Spruce Falls Power and Paper Company has recently completed a 500-ton pulp and paper mill at Kapuskasing, together with a development of 56,250 H.P. at Smoky Falls, 40 miles distant, on the Mattagami River, to supply its power. The J. R. Booth, Ltd., mill on the Ottawa River, at Ottawa, utilises an installation of 28,789 H.P., 14,000 H.P. of which is connected to electric generators, in the production of its varied output.

The larger pulp and paper mills in British Columbia, namely, Pacific Mills, Ltd., and the Powell River Company, Ltd., have hydraulic installations of 26,850 H.P. and 49,860 H.P. respectively, about 70 per cent. of each being connected to electric generators.

In the Province of New Brunswick there are four pulp mills and one pulp and paper mill, with a second paper mill under construction. The total hydraulic turbine installation of the mills providing their own power is 13,728 H.P., of which all but 1900 H.P. is connected to electric generators.

Nova Scotia has seven pulp mills in operation and one pulp and paper mill, which has recently been constructed. All but one of the pulp mills generate their own hydro power and use it without conversion to electricity. They have an aggregate installation of 16,008 H.P.

The Province of Manitoba has one mill, a pulp and paper mill erected by the Manitoba Paper Company and recently absorbed by the Abitibi Power and Paper Company. It purchases its power from the Manitoba Power Company under a long-term contract.

Literature.

Farm and Industrial Tractors. By D. N. MCHARDY. London: Crosby Lockwood and Son. 7s. 6d. net.

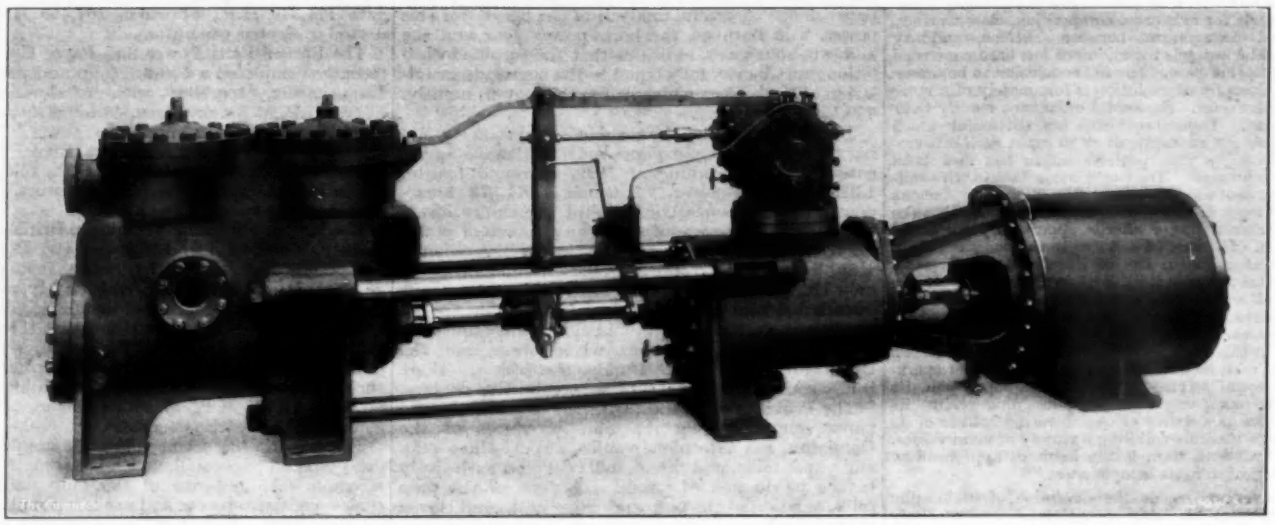
THIS is a manual for the owner and operator, and its contents are presented from the point of view of the agricultural adviser, rather than that of the engineer, by an author with experience in the efficient utilisation of mechanical appliances on the farm. Although the tractor is coming steadily, if slowly, into general use for agricultural purposes, many farmers who can afford to purchase implements of this kind are reluctant in view of their unfortunate experience of mechanical haulage during the war, when, owing to the shortage of manual labour, many hastily improvised machines were purchased which were faultily designed, unreliable and costly to work, and inefficient in performance. Since the war period, however, great improvements have been effected, both in the design and construction of tractors, while there are few farmers, or even labourers, who have not acquired sufficient practical experience of the operation of a motor car or motor cycle to enable them to handle a tractor fairly intelligently. The conditions which now prevail are, therefore, infinitely more favourable than those which existed ten years or so ago, and although agricultural horses are now practically as cheap as they were in pre-war days, there are few farms of any considerable size which cannot profitably employ a tractor. Farmers still require to be educated concerning the many and varied possibilities of the modern tractor and the saving in labour costs which a modest capital expenditure will effect, for the statutory regulation of wages of farm workers has made it absolutely necessary to secure the maximum efficiency if farming is to be carried on at a profit.

In the opening chapter of this book the author recalls in an interesting manner the pioneer work in this branch of agricultural engineering which can be said to have really commenced in 1876, when Thomas Aveling, of traction engine fame, equipped one of his engines with a reaping machine, which was exhibited at the Royal Show at Birmingham. Not much headway was made with steam as the motive power, and it remained for Ruston and Proctor to break new ground, literally and metaphorically, by applying a Hornsby-Ackroyd oil engine of 18 brake horse-power to traction purposes in 1897. This implement was exhibited at the Royal Agricultural Society's show held in Manchester in 1897 and was awarded the Society's silver medal. The engine was mounted between two steel frames, having on one end of its crank shaft a spur pinion and a pulley for driving stationary machinery and on the other end a heavy fly-wheel. Gearing was arranged between the pinion on the crank shaft and the main axle of the vehicle, giving three road speeds, and the gears were engaged by a friction clutch. There was also a winding drum and differential gearing.

The problem of designing an agricultural tractor was tackled in a very different way a few years later, when Dan Albone, a well-known racing cyclist, designed and constructed a machine known as the Ivel, in which a horizontal twin-cylinder petrol engine provided the motive power. The engine was rated at

TANDEM COMPOUND PUMP FOR AN OIL REFINERY

G. AND J. WEIR, LTD., CATHCART, ENGINEERS



only 14 brake horse-power, and the power was transmitted to the travelling wheels by chain gearing and clutches, the maximum road speed being 4 miles per hour. The writer of this review witnessed one of the early tests of this tractor hauling a self-binding harvester, which it did very effectively, but the machine was under-powered and too light for the heavier work about a farm. When the Ivel tractor made its appearance at the Royal Show in 1898, it was equipped with a more powerful engine and had two forward speeds and a reverse.

Subsequently, the building of agricultural tractors was taken up by a large number of firms, one of the earliest being Saundersons, of Bedford, whose machine was awarded a silver medal at "The Royal" in 1906. American engineers were early at work on the problem, and Henry Ford was one of the first to design and produce a practical machine of the frameless type which, in a somewhat modified form, is still being produced in large quantities at the Ford works in Cork. The trials conducted at Shrewsbury in 1922 under the auspices of the Society of Motor Manufacturers and Traders upon twenty different types of tractors, demonstrated the marked advance which had been made in tractor construction in a comparatively short time; but it is significant that out of the twenty or so machines there tested probably not more than half a dozen are now being built. The reason for this is probably the depression in the agricultural industry rather than faulty construction. A lengthy abstract of the results obtained at these trials is given by the author.

The book also contains chapters explaining in language as non-technical as possible, the construction and functions of the mechanism which is common to all. "Possible Sources of Trouble" have a chapter to themselves, and the author tells the reader how to overcome them. The chapter on "Costs of Operation" is instructive. The author states that under good management tractor work is considerably cheaper than that done by horses. He gives figures to show that the average cost of tractor ploughing on medium land is about 8s. per acre; cultivating costs round about 2s. per acre, drilling 1s. per acre and mowing 2s. per acre, while for threshing 10s. per day is said to be the average cost. The above-mentioned figures are obtained with petrol as the fuel employed and include labour, depreciation, &c., depreciation being put down at 16¼ per cent., or equivalent to a six-years' life of the tractor, which is probably a fair average. The corresponding costs when employing animal traction are not available, but they are undoubtedly higher. But, besides the advantage of cost per acre, it should not be forgotten that with mechanical haulage the land can be worked more thoroughly and deeper than is economically possible with horses, and greater advantage can be taken of spells of fine weather.

The book justifies its existence by demonstrating the wide range of applications of tractor power which are possible, and by assisting the owner to get the best out of his machine when put into service.

Horizontal Simplex Tandem Compound Gas-Oil Pump.

THE accompanying engraving shows one of a batch of twenty-four reflux gas-oil and petrol pumps of the horizontal, simplex, tandem, compound type, designed and built by G. and J. Weir, Ltd., of Cathcart, Glasgow. The duty of these pumps is to handle a certain percentage of the freshly condensed fractions after they have left the fractionating tower of an oil-refining works, and to return them to the tower to "reflux" and scrub the vapours as they work their way to the top of the tower.

The makers point out that a tandem compound design gives a better steam economy than the simple type of pump, while at the same time simplicity is achieved. One steam valve controls the steam admission to both cylinders, so that the number of moving parts is kept as small as possible, with the corresponding advantages from the reduced wear and tear point of view. The steam is used expansively in the low-pressure cylinder. The transfer passage can be seen in the illustration, connecting the two cylinders.

The steam valve gear is of the Weir piston valve type, in which the main steam slide valve is operated by an auxiliary slide valve working on a face on the main valve. In place of the normal arrangement of ports, there are five ports in the slide valve face, which enables the one valve to control the steam to both cylinders, as already stated. Steam is first admitted to the high-pressure cylinder at one side of the piston, while the steam on the other side is exhausting through the valve into the low-pressure cylinder. At the opposite end of the stroke the steam in the low-pressure cylinder is released and travels back through the valve, to exhaust, while the process is repeated on the reverse sides of the pistons.

Messrs. Weir claim that the simplex type of pump is undoubtedly superior in several respects to the duplex type. For one thing, the steam consumption of the simplex is much less than that of the duplex. Then there are fewer ports and passages, and greatly reduced clearance volume; while any wear on the valve gear of a duplex pump immediately results in the short-stroking of the pump, which entails wastage of steam, whereas a simplex pump of the Weir type will, it is stated, always give full length of stroke under all conditions of working. Moreover, there are only half the number of working parts in the simplex type, compared with the duplex, and that again means increased reliability in service.

The valves and valve seats are specially arranged with a view to quick inspection and easy overhaul. The discharge valve seat is not a driven fit, but is ground on the face and is easily removed, which allows the suction valves below the discharge valves to be readily taken out.

The valves, which are of special design, are of stainless steel, and the seats are of the same material. The pump rod is also of stainless steel, and is joined to the mild steel steam piston-rod by a forged steel crosshead. The buckets are fitted with a special type of renewable packing rings. The oil end of the pump is of cast iron, and it has a cast iron liner and cast iron buckets. The steam cylinders are lagged with insulating composition and neatly covered with planished steel cleading.

A mechanically operated sight-feed lubricator supplies oil to the steam cylinders through the steam valve. These gas-oil reflux pumps are, we understand, capable of delivering 122 Imperial gallons of oil per minute when running at 16½ double strokes per minute, against a pressure of 300 lb. per square inch, when supplied with steam at 175 lb. per square inch gauge. The pump cylinder is 9in. diameter, 18in. stroke, with 12¾in. diameter high-pressure cylinder and 20in. diameter low-pressure cylinder.

The petrol reflux pumps are each designed to deliver 73 Imperial gallons of the spirit per minute when running at 16½ double strokes per minute, against a pressure of 300 lb. per square inch, when supplied with steam at 175 lb. per square inch gauge. The dimensions are 7in. diameter by 18in. stroke, with 10in. diameter high-pressure and 16in. diameter low-pressure cylinders.

Canadian Engineering News.

(From our own Correspondent.)

St. Lawrence Deep Waterway.

ARISING out of a series of conferences held recently between representatives of the Dominion Government and the provinces of Ontario and Quebec to discuss water power matters, the belief is growing that any big, concerted effort at constructing a St. Lawrence deep waterway is out of the question for at least ten years. Such a project, to be undertaken as a single, unbroken scheme similar, for example, to the new Welland ship canal, is not to be considered, as far as Canada is concerned. It was disclosed at the conferences between the three Governments that, eminently preferable, both from a financial and an engineering standpoint, would be an enlarged seaway brought about by a slow, sectional method. It was shown by engineers who supplied data to the conferences that a much cheaper method of providing power, and eventually a deeper seaway, would be to procee done step at a time, or one power development at a time, the dam necessary for this development in each case being so planned, so constructed and so situated as to become also an integral part of the larger seaway to follow. As to the international features of the St. Lawrence situation, there does not at present seem to be much anxiety on the part of the Federal Government to do business with the United States in the matter. Any further communications are certain to await a final disposition at Washington of the present tariff legislation which will have an important effect on Canadian commerce. A large factor in the further postponement of the St. Lawrence power-seaway project is the decision, made known some months ago by the Ontario Government, to secure all the water power possible from the province of Quebec before turning to the St. Lawrence. Quebec has an abundance of undeveloped power sites, and some of them are now being harnessed to deal with the future needs of the two provinces.

Gatineau Power Extensions.

During 1929, generators of an aggregate capacity of 83,000 H.P. were installed in the Farmers, Chelsea and Bryson hydro-electric plants of the Gatineau Power Company. In the Farmers power-house, an additional 24,000 H.P. unit raised the total installed capacity to 96,000 H.P., and the 34,000 H.P. generator started in the Chelsea station, a mile above Farmers, increased its installed capacity to 136,000 H.P. The third additional generator installed during the year was in the Bryson plant, situated on the Ottawa River 50 miles above the city of Ottawa. The generator has a capacity of 25,000 H.P. and raises to 50,000 H.P. the installed capacity of this station. With the starting of these additional generators, the aggregate installed capacity in the plants of the Gatineau Power Company was increased to 562,600 H.P. During the year, another storage dam on the upper Gatineau River was completed. The new dam, storing the water of Lake Cabonga, and the present Mercier storage dam form reservoirs ranking with the large water storage systems of the world. The two reservoirs have a combined capacity of 145 billion cubic feet. Situated in the heart of one of the great timberland areas of the Canadian International Paper Company, the Cabonga dam is 46 miles above the Mercier dam and forms a reservoir draining a territory of 1150 square miles. The new reservoir materially assists the Mercier reservoir in regulating the flow of the Gatineau River.

Copper Output Growing.

One concrete result which has come from the development of the new mining areas in Northern Quebec, Ontario and Manitoba, is the importance which the production of copper has assumed in Canadian mining. Output has more than doubled within the past four years and continued growth is expected. Production in Canada amounted to 121,000 tons in 1929, an increase of 20 per cent. over 1928. Owing to the higher prices prevailing, the total value was more than 80 per cent. greater. In a recent survey, the Canadian Department of Mines stated that Canada should be producing copper at the rate of 160,000 tons a year by the end of 1930. British Columbia has long been the principal source of Canadian supplies of copper. Ontario stands second and her output has been increasing rapidly. The development of the Rouyn district in the province of Quebec during the past few years has given that province a prominent place, and aggressive development is taking place in Northern Manitoba. Of the production of 160,000 tons forecast for 1930, the Department of Mines estimates that British Columbia will produce about 60,000 tons; Ontario, 50,000; Quebec, 35,000, and Manitoba, 15,000 tons. British Columbia still holds first place, but the newer fields are rapidly forging ahead, Manitoba appearing for the first time as an important producer.

Railway and Road Matters.

CLAUSE 23 of the Road Traffic Bill, which was passed by the Standing Committee on April 8th, authorises the Ministry of Transport to hold inquiries—similar to those held since 1842 into railway accidents—into such accidents, as are thought fit, that have arisen "out of the presence of a motor vehicle on the road."

WE are sorry to learn that Mr. W. A. Ree, the chief stores superintendent of the London, Midland and Scottish Railway, has, owing to ill-health, felt compelled to retire and ceased to act as from March 31st. Mr. Ree had been what, in railway circles, is called a "goods" man on the London and North-Western and then on the L.M. and S. since 1892, and became the chief stores superintendent in 1927.

DURING the year ended March 31st, 1929, there were 1282·15 miles of new railway opened in India, of which 476·22 were of 5ft. 6in. gauge, 597·93 miles were of metre gauge, and the remainder of 2ft. 6in. or 2ft. During the year there were 653 miles sanctioned, of which 440·81 miles were to be of 5ft. 6in. and the remainder of metre gauge. At the end of the year there were 2896·17 miles under construction, of which 1375·66 miles were of 5ft. 6in. gauge, 1288·74 miles were of metre gauge, and the remainder of 2ft. 6in. or 2ft.

WHEN Sir Ralph Wedgwood was, on April 8th, giving evidence on behalf of the London and North-Eastern against the Bill promoted by the London, Midland and Scottish to obtain direct access to Victoria Docks, he said that much of the traffic dealt with at the docks was road-borne. Asked by the Chairman whether the road was still gaining over the railway, Sir Ralph replied that, taking the situation generally, the railways had been holding their own lately, but at a considerable sacrifice in rates. As far as London was concerned, however, they had to bear in mind that the advent of new roads would make road competition more keen.

THE Ministry of Transport railway statistics for January have just been issued as a Stationery Office publication, price 3s. 6d. They show that, compared with January, 1929, the number of passenger journeys increased by 4·7 per cent., and the receipts from passengers advanced by 2·0 per cent. We notice that the drop in full-fare-paying passengers was only 553,930, instead of six or eight millions. The coaching train mileage increased by 2·1 per cent. The total tonnage advanced by 3·9 per cent., mainly due to an increase of 3·3 per cent. in coal, coke, and patent fuel. The freight train mileage increased by 2·6 per cent., the average train load rose from 130 to 130¼ tons, and the net ton-miles per engine hour from 423¼ to 436.

IN 1901 there was introduced into this country from the United States a new method of operating points and signals by power. Like the Westinghouse system, it was by air, but the air, instead of being compressed at high pressure and controlled electrically, was low pressure, and the valves controlling the motors were, in turn, actuated pneumatically. In addition to the main supply there were four minor pipes for the valves of points and three for those of signals. The system had many merits and was much used by the London and South-Western and the Great Central. In time it was, however, found that the maintenance of the control pipes was expensive, and the Southern changed its equipment at Clapham and other places so that the actuation was electro-pneumatic. Some of the signalling done on the Great Central was between Hyde Junction, through Guide Bridge, to Ardwick Junction. That length is now being similarly converted by the London and North-Eastern.

WE regret to have to record that the passenger who was seriously injured in the Culgaith collision of March 6th succumbed to his injuries on April 17th. As the driver of the passenger train was killed in the accident the facts have already been investigated by a coroner and his jury, but as this second death occurred in Carlisle Infirmary the necessary inquiry will have to be an entirely new one. It must suffice, then, only to relate that, as observed in this column on March 21st, the driver of the passenger train started against a signal. An unfortunate feature about the accident is that it was the first in which there was a loss of life among the passengers since the Ashchurch collision of January 8th, 1929. Only twice has that interval of fourteen months been exceeded. One occasion was the sixteen months between the Grangemouth collision of December 15th, 1900, and the Sutton Coldfield of April 12th, 1902, and the other was the twenty months between the West Hampstead collision of October 26th, 1907, and the Sudbury derailment of July 2nd, 1909.

THE Bill promoted by the London, Midland and Scottish Railway to build a new line from the Tottenham and Forest Gate branch to the Victoria Docks, to avoid running over the London and North-Eastern Railway, which was passed by a Select Committee of the House of Commons on April 9th, raised two points of general interest. One was that the London, Midland and Scottish must continue the agreements made in 1872 by the London and North-Western and in 1876 by the Midland—both constituent companies in the L.M.S. The other point was that the London and North-Eastern had just had a grant made by the Duckham Committee towards a £110,000 scheme for improving the sidings at Temple Mills, which would eliminate many of the causes for the delays of which the L.M.S. complained, and which had, in fact, led to the present proposals. On that point Mr. Ormsby-Gore, the Chairman, said that he and the members of the Committee desired to express their regret that when the promoters decided to go on with this scheme and the L. and N.E.R. decided to make improvements at Temple Mills, neither was made acquainted with the intentions of the other. They continued the old narrow traditions of competition which operated so much to the public detriment and led to so much unnecessary duplication of railway capital before the amalgamations under the Act of 1921. If the matter had been discussed beforehand a great deal of time and money might have been saved. The Committee hoped that instead of this "beggar-my-neighbour" attitude in future the great railway companies when promoting Bills which affected the interests of their neighbours would take early opportunities of consultation and discussion.

Notes and Memoranda.

A NEW ENGLAND electricity supply company recently put an all-electric kitchen on wheels and toured a distance of over 1300 miles, so that more consumers and prospective consumers might be reached than would be possible with any other form of exhibit. The apparatus included a water heater, a cooking range, a refrigerator, a water pump, an iron, table appliances, and electric light within, combined with floodlighting without. Instead of having merely the appearance of a van, the whole vehicle was constructed in the form of a bungalow.

SOME figures published in the *Swiss Observer* reveal the progress that can be made in domestic electrification. In that country during 1928, 131,000 pieces of electric heating and cooking apparatus were installed. At the close of 1928 about 1,300,000 of these appliances were in operation throughout the country, comprising 124,000 kitchen stoves, 70,000 boilers, 180,000 kettles, tea and coffee pots, 600,000 electric irons and 140,000 stoves. The proportion thus attained is that of about one apparatus for every three heads of the population. Were these appliances to operate simultaneously they would consume, roughly, ten times the quantity of electricity necessary to run all the electric trains on the Swiss railway lines during the traffic period.

VAST quantities of potential power, numerous dam sites and the resources and industries of 45,000 square miles of territory, are analysed in a report on "The Green River and Its Utilisation," just completed by Ralf R. Woolley, federal hydraulic engineer in charge of the Salt Lake office, which covers the 730 miles of the river proper flowing in Wyoming, Colorado, and Utah, and also the extensive tributaries. According to the report, the potential power of the basin totals 759,600 horse-power, while to-day there is less than 2000 horse-power developed. Thirty-one of the sites are in Utah and are capable of producing a total of 547,000 horse-power, 479,000 horse-power of which could be developed on the Green River itself. Nine sites in Wyoming are capable of developing 11,100 horse-power, and twelve in Colorado have a potential output of 201,000 horse-power.

COAL-MINING to music is the prospect suggested by interesting tests carried out in the Camerton Pit, Somersetshire, on March 18th, with a portable receiver. The set which incorporates a screen grid valve, detector and two stages of low-frequency, picked up 5XX while on the surface, but ceased to function immediately the cage began to descend. At the bottom of the shaft, some 1000ft. below the surface, 5XX was again tuned in at about half normal strength, though full strength was secured by a slight adjustment to the high-frequency condenser. London Regional came in strongly, both with the frame aerial in the set and with an external aerial, but was more stable with the former. A curious fading effect was observed, London Regional "disappearing" completely at intervals of 15 seconds. On the other hand, no trace of fading was observed on the transmission of Radio Toulouse, which was received at very good strength.

EXPERIMENTS are being carried out in the Holland tunnel on the use of a photo-electric cell to indicate the concentration of exhaust gases in the atmosphere. As used at present, the light sensitive device is situated in an exhaust duct over the traffic lane at a point near the New York exit where the roadway gradient is at its maximum and where the amount of exhaust from the heavy truck traffic is greatest. By means of mirrors, a beam of light is caused to travel 300ft. from an electric lamp to the photo-electric cell through the air being exhausted from the tunnel. The photo-electric current, after being amplified, operates an indicating and recording device situated a quarter of a mile from the tunnel's portal. An indication of increasing haziness is a signal to the supervisor to increase the amount of ventilation. The equipment is being developed by the American General Electric Company along lines suggested by the engineers in charge of the tunnel.

A PAPER discussing "Photo-electric Cells and their Applications," was read by Dr. T. H. Harrison before a recent meeting of the Television Society. The earlier section of the paper deals with the history of the photo-electric effect, and then goes on to describe the various existing types of cell and the methods of manufacture. In dealing with the various applications, the first mentioned is that of photometry, the development of the red sensitive cell having made possible the satisfactory measurement of candle-power of electric lamps. Particular interest is attached to an automatic photometer for giving a visible record of the candle-powers of an electric lamp in different directions. By using the photo-electric cell to operate a relay when the illumination passes through a critical value, a variety of applications can be obtained, such as alarm systems for smoke production, colour changes as in titration, automatic street lighting control, burglar alarms, &c.; also printing and textile machines can be controlled by means of stencils.

IN a recently published report, Mr. C. A. Seyler records some of the results of his work on the microscopical examination of coal, on which he has been engaged during the past few years. An account is given of the method of preparing thin sections of coal for examination by transmitted light, but the report is chiefly concerned with the methods of, and the results obtained by, polishing and etching flat surfaces of coal. This method, which is based on metallographic practice, and was first applied to coal by Winter, has been modified and developed by Mr. Seyler. By its aid, plant structures in coal have been shown to be far more numerous than was previously supposed, and there is the further advantage that sections can be prepared in three determined planes meeting at right angles in a selected part of a plant fragment, which is essential to the interpretation of structure. The report also includes a description of a simple photo-micrographic apparatus, with manipulative details, particularly suited to photography by vertical illumination. The technical side of the work is followed by an account of the cell structures found in coal and of their various states of preservation, and of the identification of definite plant tissues.

Miscellanea.

THE German Telefunken Company has secured a contract for the erection at Nanking of one of the most powerful wireless stations in the world. Chinese engineers are to proceed to Germany to study modern radio methods.

THE 200ft. masts at Brookman's Park would look rather puny against the three 500-footers which the Radio Communication Company is to erect at Slaithwaite for the Northern Regional transmitter. It seems that there are no height restrictions at Slaithwaite, aircraft not being so plentiful in that neighbourhood as in the northern suburbs of London.

THE Postmaster-General, in a written answer to a parliamentary question, states that the capital expenditure involved in the proposal to establish telephone services with Canada, Australia, South Africa, India, and the Argentine is about £125,000, exclusive of land lines. This, however, depends on an agreement with the distant countries concerned. In regard to India and South Africa, it is doubtful whether those countries will be in a position to co-operate in opening a service for some time to come.

THE report of the Institute of Fuel for 1929 shows that the year was a busy one. The total membership at March, 1930, was 800, of whom 562 were ordinary and 77 collective members. There were in 1929 a number of very successful meetings, while 30 papers were submitted to the "Proceedings" of the Institute in the twelve months. The annual dinner last October was a most successful function. Sir David Milne-Watson remains in office as President for a further year and two vacancies on the council have been filled by the election of the Earl of Inchcape and Prof. M. W. Travers.

THE statement that no pig iron was imported into the Tees during March is contained in statistics issued by the Tees Conservancy Commission in respect of iron and steel imports for the five months ended March 31st. Pig iron imports for the five months were 4935 tons, compared with 17,320 tons for the corresponding period of last year, but only 54 tons in the pre-war period. Imports of crude sheet bars, billets, blooms and slabs were 45,551 tons, compared with 19,970 tons in pre-war days, and plates, bars, angles, rails, sheets and joists totalled 15,013 tons, against 11,242 tons before the war.

IN order to be able to meet the rapidly growing demand of the capital for electrical energy with the same security in the future as hitherto, the Berlin Municipal Electricity Works A.G. (Bewag) has laid down a long-date building programme, which provides for the timely installation of the necessary plant. This programme takes full account both of the requirements of absolute reliability and of the necessity for maximum efficiency in operation and most economical use of material. As part of this programme, the West Power Station is now taking shape on the right bank of the lower Spree near Siemensstadt, with an output of 228,000 kilowatts.

AT the first annual dinner of the London Section of the Society of Motion Picture Engineers an historical display of films was shown illustrating the progress made from 1896. Included in this display was a lecture film explaining and illustrating the principles of sound recording and reproduction by the Western Electric Company, Ltd. There was also included an exhibition of apparatus relating to the film industry, including an optical magnifier for the examination of records, a model of a photographer's sound recording system, a magnetically operated mercury-vapour clock, double turntable cinema musical equipment, a rapid visual method of measuring the reverberation in a hall and high-power amplification equipment.

A NEW body to be known as the Central Council for Rivers Protection has been formed. The Central Council will co-ordinate the work of its constituent bodies in order to bring about an improvement in the condition of the polluted rivers of England and Wales, and to renew pressure upon the Government with a view to early action being taken. The Council expressed keen disappointment that the new Land Drainage Bill, which has just been introduced into the House of Lords at the instance of the Ministry of Agriculture and Fisheries, makes no reference whatever to the question of rivers pollution. It was decided to ask the Parliamentary Secretary of the Ministry of Agriculture and Fisheries—Dr. Addison—to receive a deputation.

IN a list of works to be carried out for the relief of unemployment, which was approved by the Manchester Unemployment Works Committee on April 15th, is a scheme submitted by the Electricity Committee for the construction of low-tension distributors in the city streets. The work conforms with suggestions made by the Electricity Commissioners, and is estimated to cost £100,000, a substantial portion of which will be paid to the Corporation by way of Government grants. Other schemes comprise the erection of new washhouses in Clayton, Openshaw, Hulme and Abbey Hey, Gorton, together with public baths at New Moston. These proposals are to be submitted for the approval of the Finance Committee, after which application for grants will be made.

DURING the first quarter of this year, the electro-technical industry was not spared the effects of the continued economic depression in Germany. The development of home sales continued unfavourable, especially as the Reich Post Office, the Reich Railways, and other Government and municipal authorities were very slow in placing orders that had been expected. The demand for electric articles for everyday use showed a considerable diminution, owing to the bad economic situation, and only a few orders were received for the larger electrical appliances, business in which was appreciably affected by the shortage of capital and high rates of interest. Industrial consumption further decreased on account of restrictions of activity, closings-down and amalgamations, and a similar falling-off occurred in orders from farmers. On account of the great reduction in building work, the expected seasonal revival in installation business did not manifest itself. Prices are consequently very low. Export sales afforded a certain compensation in various branches of the electro-technical industry, although prices show a marked decrease owing to the greatly increased competition from other countries.

CANADIAN PULP & PAPER MILLS AND POWER PLANTS

(*For description see page* 459).

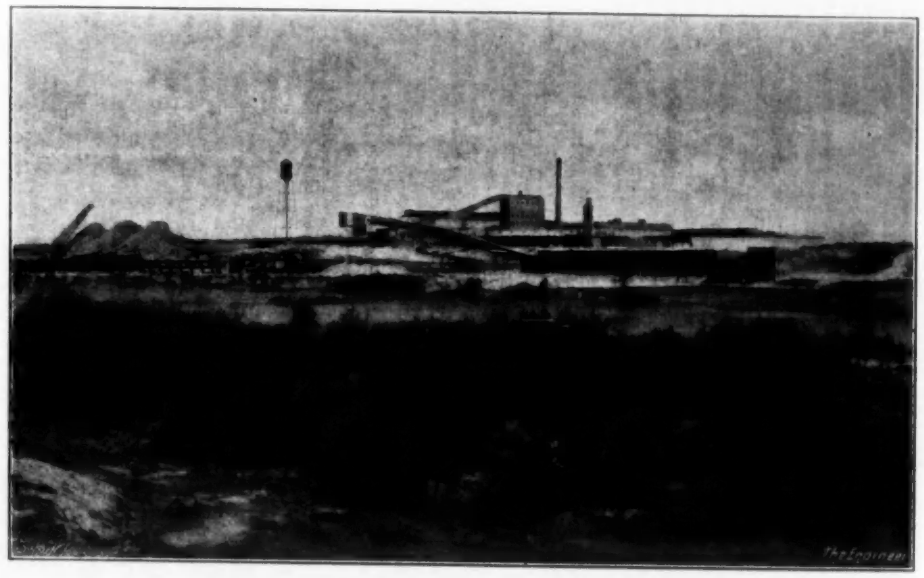


FIG. 1—PRICE BROTHERS' MILL AT RIVERBEND, QUEBEC

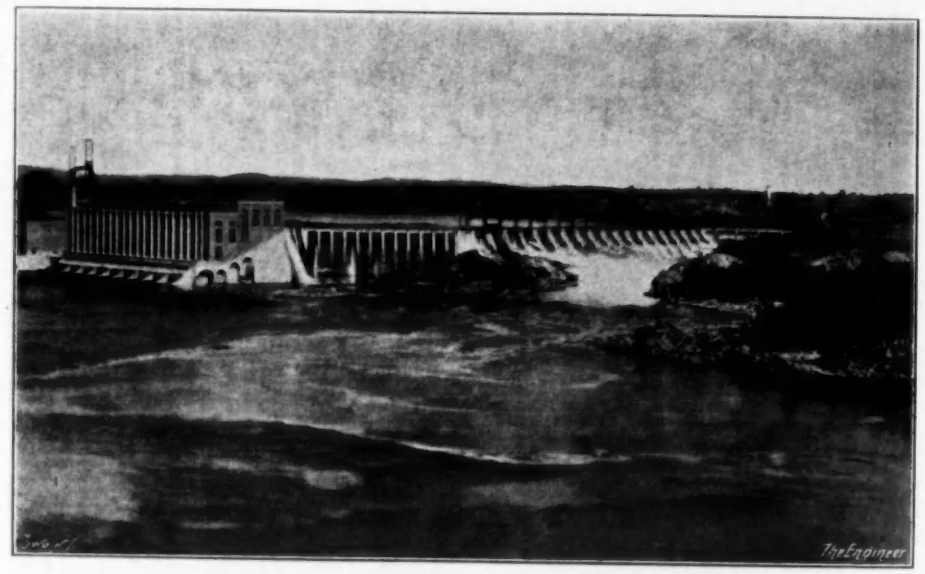


FIG. 2—LAURENTIDE POWER PLANT AT GRAND'MERE, QUEBEC

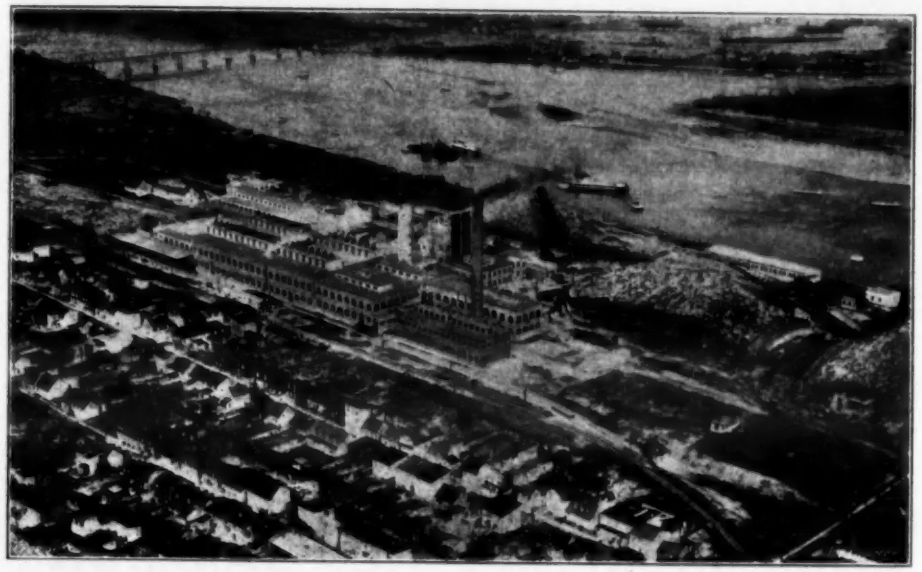


FIG. 3—MILL OF THE CANADIAN INTERNATIONAL PAPER COMPANY, THREE RIVERS, QUEBEC

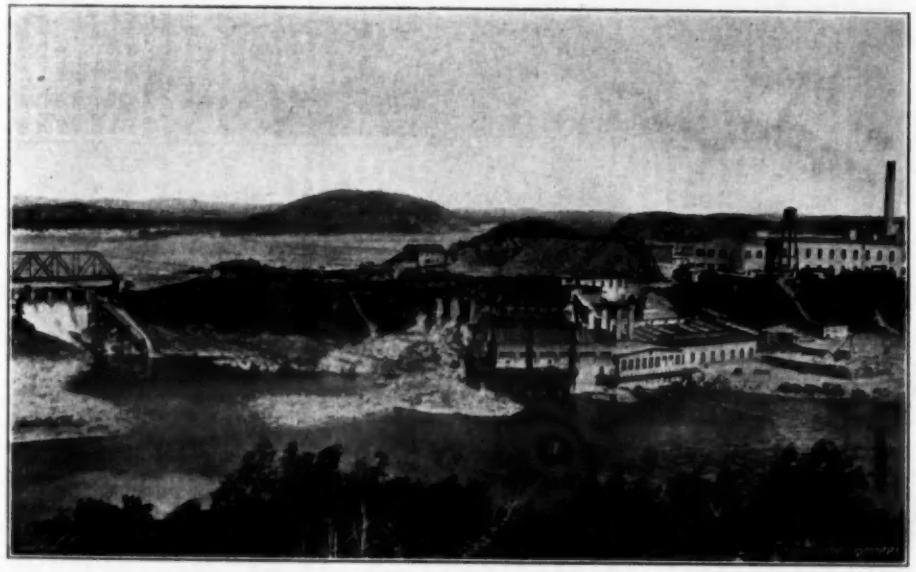


FIG. 4—ESPANOLA PULP AND PAPER MILL, SPANISH RIVER

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Contents.

THE ENGINEER, April 25th, 1930.

	PAGE
A SEVEN-DAY JOURNAL	449
THE AUTOMATIC STABILISATION OF SHIPS. No. IV. (Illus.)	450
INSTITUTION OF NAVAL ARCHITECTS. No. III.	452
EMPIRE MINING CONGRESS IN SOUTH AFRICA	455
THE LOCHABER HYDRO-ELECTRIC POWER UNDERTAKING. No. I. (Illus.)	456
THE WORK AND INFLUENCE OF THE ENGINEER	457
WATER POWER IN THE PULP AND PAPER INDUSTRY OF CANADA (Illus.)	459
LITERATURE	459
HORIZONTAL SIMPLEX TANDEM COMPOUND GAS-OIL PUMP (Illus.)	460
CANADIAN ENGINEERING NEWS	460
RAILWAY AND ROAD MATTERS	461
NOTES AND MEMORANDA	461
MISCELLANEA	461
LEADING ARTICLES—	
The Naval Limitation Treaty	463
Speed Signalling on Railways	464
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. (Illus.)	464
SIXTY YEARS AGO	465
CO-OPERATION IN A SCIENTIFIC INDUSTRY	465
THE INTERNATIONAL RAILWAY CONGRESS. No. I.	466
VERTICAL RETORTS FOR GAS MAKING	467
CAUSES AND PREVENTION OF VIBRATION IN MOTOR SHIPS. (Illus.)	468
THE BEHAVIOUR OF TWO PASSENGER VESSELS. (Illus.)	469
SOUTH AFRICAN ENGINEERING NOTES	471
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	471
Lancashire	472
Sheffield	472
North of England	473
Scotland	473
Wales and Adjoining Counties	473
LAUNCHES AND TRIAL TRIPS	473
CURRENT PRICES FOR METALS AND FUELS	474
FRENCH ENGINEERING NOTES	475
BRITISH PATENT SPECIFICATIONS. (Illus.)	475
FORTHCOMING ENGAGEMENTS	476

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THE APRIL NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

VOL. CXLIX No. 3876

APRIL 25, 1930.

The Naval Limitation Treaty.

THE London Naval Conference, which adjourned this week after a session lasting three months, has, in our judgment, achieved a substantial measure of success. If it has not brought about that universal reduction and future limitation of naval armament which was the grand objective in view, at least it has averted the danger of competitive building between the three major naval Powers for a period of not less than six years. The battleship "holiday," which normally would have ended next year, has been prolonged until 1936. To the three Powers concerned this represents a saving of over £160,000,000, Great Britain's share being estimated at £70,000,000. To our over-burdened taxpayers this large reduction in our future commitments should bring some relief. Further economies will be effected by the scrapping of five capital ships and the scaling down of other ship establishments. The total saving on naval expenditure during the years ahead cannot yet be stated with precision, but it will represent a very considerable sum. Even more important, however, are the political effects of the agreement which has been reached. As a result of the London Conference Anglo-American relations have distinctly improved. America's long-cherished ambition to possess a fleet second to none is on the point of realisation, without involving that vast expenditure which would have been necessary had the element of competition continued to dominate shipbuilding programmes. Her future battle fleet will be slightly stronger than ours, especially in gun power; her cruiser force will be superior in heavy ships and inferior in 6in. gun vessels, but measured by the "yardstick" formula it will be quite equal to the British cruiser establishment. In aircraft carriers, destroyers, and submarines the two fleets will be mathematically equal. It may not be ungracious to point out that the United States is very markedly the gainer by this arrangement, since she is so much less dependent than the British Empire on sea power as a vital instrument of national defence and existence. When the strategic situation and requirements of each nation are analysed and compared it will be found that the United States, in gaining "parity," has actually gained supremacy. That fact is, we believe, realised by all intelligent Americans, and it is just because they do appreciate the magnitude of the British sacrifice in the cause of friendship that the future relations between the English-speaking Powers promise to be cordial and free from misunderstanding.

It is but fair to recognise that such an agreement, fraught with infinite hope for the future peace of the world, would have been impossible without the co-operation of Japan. Throughout the prolonged negotiations in London the statesmen of the Far Eastern Empire have worked loyally for the common good. To them the maintenance of a seven-ten ratio in non-capital warship tonnage appeared to be vital to the national interest. As far back as the Washington Conference they made their acceptance of the three-five ratio in battleships conditional on the granting of a higher percentage in cruisers, destroyers, and submarines—a fact which appears to have been overlooked by American observers at the present Conference. We have every sympathy with this Japanese point of view, knowing it to be dictated, not by questions of prestige, but by a cool appraisement of the lessons of history, supplemented by the results of "war games" played out on the "Kriegspiel" board, which is a necessary adjunct of every naval staff college to-day. The contention of Japanese strategists was that with a seven-ten fleet of cruisers and other light craft their navy would have a sporting chance of holding its own against any hostile force that crossed the Pacific, whereas, with a six-ten fleet, successful resistance would be out of the question. We may add that the whole problem has been expounded to us very lucidly by one of the ablest officers of the Japanese delegation. All the more honour, then, to the Japanese statesmen who, in order to promote the cause of disarmament, have agreed to accept a measure of naval strength which their professional advisers declare to be inadequate. The British Empire, it is true, had already made the same brave gesture, since no reasonable person supposes that our future fleet, as regulated by the new Treaty, will be strong enough to guard the 80,000 miles of trade routes which represent the arteries of the Empire. We and Japan are accepting with open eyes those "risks of peace" to which the Prime Minister referred on the eve of the Conference. For the first time in modern history we are cutting the Navy down to a point far below safety level. It is a grave decision to take, having regard to our unparalleled commitments, but it is one, we think, in which public opinion throughout the Empire will concur. Under prevailing circumstances there is no reason or excuse for competitive building on the part of any Power, least of all between ourselves and the United States, which, broadly speaking, has common ideals and interests, to say nothing of a common culture. Turning to the more concrete effects of the new Treaty, it will result in the early disappearance of several fine ships to which a more than sentimental interest attaches. On the condemned list are the four "Iron Dukes" and the "Tiger." The "Iron Duke" and her sisters are unquestionably among the finest battleships we have ever produced. On a reasonable displacement—25,000 tons—they embodied excellent fighting qualities, both offensive and defensive, and a remarkable degree of mobility. The "Benbow," of this class, was completed in October, 1914, with a designed speed of 21 knots. Nearly fourteen years later we were on board this ship in the Mediterranean when she was running her annual full-power trials, on which occasion she logged a steady 20·9 knots for two hours. This example, which could easily be multiplied, demonstrates the superlative workmanship put into the hull and machinery of British warships. The "Iron Duke" will always be remembered as the flagship of the Grand Fleet for the first two and a-half years of the war. The "Marlborough" was the only British battleship to be torpedoed at Jutland, and although hit abreast the boiler rooms, where there is no internal protection, she remained in the fighting line for several hours. It will be seen, therefore, that by destroying this quartette of battleships we are discarding a squadron of real fighting value, which any navy would be proud to possess.

The "Tiger," also marked down for the scrap heap, is another fine ship, more valuable, in our opinion, than her faster but less robust successors of the "Renown" class. At the Battle of Jutland she gave and received heavy punishment, and to-day, after fifteen years of service, is still able to steam and fight with the best. Indeed, next to H.M.S. "Hood," she is probably the most efficient battle-cruiser afloat. The new Treaty, it is understood, will involve the scrapping of the four "Hawkins" cruisers, which were built under the Emergency War Programme for the special purpose of hunting down hostile raiders. Although of considerable age, they are splendid ships, and, as we are able to testify from personal experience, first-class sea boats. It is well known that the existence of these vessels—9750 tons, seven 7·5in. guns—was responsible for the decision of the Washington Conference to establish 10,000 tons and 8in. guns as the maximum displacement and armament of future cruisers. From the United States Navy are to disappear the old 12in. gun battleships "Utah," "Florida" and "Arkansas," which, although recently reconstructed, are in no way comparable in fighting value with the "Iron Dukes." Japan is to sacrifice only one vessel, the battle-cruiser "Kongo" or "Hiyei," of a type almost identical with that of H.M.S. "Tiger." So far as the British Empire is concerned, the building of 8in. gun cruisers is to cease, since we are already up to our quota of fifteen. The United States, with eight of these vessels built or completing, is to build seven more between now and 1935, while reserving the right to add three others subject to arrangement with Japan. The last-named Power is granted twelve 8in. cruisers, viz., eight of 10,000 and four of 7100 tons, all of which are now afloat or under construction. As regards the destroyer and submarine categories, the United States, owing to its immense surplus, will have to scrap many more vessels than the other two Powers. France and Italy, while unable for various reasons to join in the pact which the British Empire, the United States and Japan have signed, have signified their adherence to many important clauses, notably the extension of the battleship holiday and the "humanising" of submarine warfare. Each, however, reserves the right to build 27,000 tons of capital ships between now and 1936, and there is reason to believe that France, apprehensive as she is of the German armoured ship "Ersatz Preussen," intends to lay down in the near future a battle-cruiser of 23,000 tons, armed with 12in. guns.

Such is the substance of the new Naval Limitation Treaty, which we hope to discuss in more detail in a later issue. It would be churlish not to pay a tribute to the patience, vision, and good will with which these protracted and delicate negotiations have been conducted by all parties. In contrast with previous gatherings of the kind, there has been very little acrimony. The delegates of all five Powers came to London determined to do what was humanly possible to make the Conference a success. If the result is not quite as complete as could be wished, it nevertheless stands as an achievement that will rank high in the annals of diplomacy.

Speed Signalling on Railways.

The sight of a railway signal prompts varied reflections. There is the simple manner in which, considering their importance, the indications are conveyed—an arm in the horizontal position, unless it has a fish-tailed end, means "Stop," but when inclined to an angle of 45 deg. signifies "Clear." The corresponding night signs, given by coloured glasses in a spectacle attached to the inner end of the arm, are red and green respectively for the square-ended arm, and yellow and green for the fish-tailed signal. The latter is a distant signal, which is purely a repeater to give a driver 800 yards' or so advance intimation of the condition of the stop signals at the box he is approaching. Its arm, too, has the same two positions as the arm of a stop signal. Another thought turns upon the importance of the signal in the matter of safety. It tells the driver that he must stop or that he may proceed. Consideration of that fact brings out the vital necessity that signals shall be well maintained, that the operating wires be correctly adjusted to suit the contraction and expansion due to changes in the temperature, that the lamps for night use be thoroughly trimmed and filled, and that the spectacles be kept clean. The signalman shares in that responsibility, as on him depends the adjustment of the wires, the burning of the lamps, and he must see that the arms respond to the levers whereby he moves them. To help him in his work he is provided with means for adjusting the wires and is given an indicator to tell him that the light is burning, and an electrical repeater which shows the condition of the arm for all distant signals and for those other signals the lights and arms of which he cannot see. Therein the signalman is at a great advantage over the driver, as, except a detonator-warning in foggy weather, the enginemen have as a rule no assistance towards their observation of the signals. Another thought that might come to mind is the little change that has been made in the symbols of fixed signals. Until quite recently, when light signals were introduced and now, with the movement of the signal arm through the upper instead of the lower quadrant when moved from the horizontal position, only two modifications have been made in the semaphore signal. One is that a white light for the "clear" indication has been superseded by a green light, and, as a spectacle glass falling out of its frame would cause a white light to be exhibited, such an indication has now to be regarded as a "danger" signal. The other change is the substitution of yellow for red for the "warning" position of distant signals. In all other respects the running signal of to-day is, except in details of construction, the same as when C. H. Gregory introduced it on the Brighton Railway in 1842, adopting the idea from the telegraph semaphore invented in 1796 by Claude Chappe.

One feature about railway signals that surprises the uninitiated is the certainty with which a driver, when approaching a busy station or junction, picks out from amongst a host of signals those that apply to him. The appearance of a green light is not sufficient, as if there are parallel or converging lines the indication may apply to another train. A good deal has been done by signal engineers, by placing signals next to, or over, the line to which they apply and by separating the signals for one line from those for another, to render the reading of signals easy, but when two or more lines run parallel to each other and there is a junction ahead, particularly if it leads in more than two directions, it is difficult to group together satisfactorily the signals for each line. This was a question which was discussed at a meeting a fortnight ago at the Institution of Railway Signal Engineers, when a paper by Messrs. R. S. Griffiths and T. S. Lascelles was read. Its title was "The Problem of Signal Aspects: What Must we Tell the Man on the Footplate?" The paper obviously was so worded as to provoke discussion, and, moreover, around the question whether what is known as speed signalling is preferable to the existing principle which, to indicate the contrast, is termed route signalling. Under the latter there are, at a junction, a number of "splitting" signals; that is to say, each direction that can be reached at the junction has its own signal arm and each arm corresponds, in its position on the signal post, to the direction it applies to, *i.e.*, the left-hand direction is controlled by the left-hand post, the middle road by the centre post, and so on. But not only is the driver given his direction guidance in a very clear manner, but he is also told the character of the junction through which he is about to pass. That is done by "stepping" the arms and making the signal for the junction through which he may pass at normal speed take the highest of a row of arms and that for the junction for a moderate speed an arm at a slightly lower level, whilst the arm for entering a loop or through a connection on a sharp curve is a relatively low one. The symbols used in speed signalling are much simpler, but whilst giving the same indications as "stepped" signals, they do not indicate direction; there is but one post and by the position of the arms thereon a driver is given the instructions conveyed in the other system by "stepping," *i.e.*, to travel at normal, medium or low speed. Is that enough? We have already shown that a driver has none of the assistance in his observation of the signals that a signalman gets, and we also have mentioned the confusion that must often be experienced when approaching a busy station or junction. Are we, in introducing speed signalling, going to add to his troubles? Does a driver want to know the direction for which the junction ahead is "set," or is it sufficient for him to know that the road made is one over which he can maintain his speed or over which he must reduce it? Many would answer our question as to speed signalling in the affirmative, but were they asked how many junctions are there in this country at which speed may be maintained in either direction they would be bound to admit that there are very few. It is the fact that in all but a small percentage there has to be a reduction, perhaps only small, of speed for one of the two directions to be taken; in other words, the two indications of normal speed and medium speed are almost universally necessary. But why not, in the few such cases of junctions that permit of equal speed for both directions, lay down instructions that one of them shall be given the preference? Certain it is that speed signalling can call for reduced speed in each direction where that is necessary, which is something that route signalling cannot do.

We would not, however, have it thought that we have come out as advocates of speed signalling. Whilst it is true that experience in America, Australia, and New Zealand is in favour of the change, we claim that that is little justification for our methods to be altered. British conditions are different. For one thing, our lines are already fully signalled and our signalling system standardised on the route system and the enginemen are used to it. Again, our traffic is so much denser that the delays which would arise out of a train being turned into the wrong direction would be very serious. In the latter relation it must be remembered that a driver may not set back his train at his own sweet will; moreover, he may have run so far that he must proceed to some station or signal-box where there are two cross-over roads—which is not the case generally—and there run round his train, take it back on the other road to the junction and there again run his engine round—operations that would take the best part of an hour. The subject has many aspects, and so we are going to imitate the example of the authors of the paper mentioned above and, having asked the question and given some of the arguments for and against, leave it there and let the "Footplate" tell us what it wants. In leaving the matter an open one we have one point in mind, and that is that the report of the Committee which has been considering automatic train control will probably be out shortly. What the recommendations will be we do not know, but can only hope that, in view of the continued rarity of accidents from over-running signals and of the financial condition of the companies, compulsory adoption will not be recommended. If, however, automatic train control were adopted the driver would be in as good a position as the signalman in respect of his knowledge, in all weathers, of the condition of his signals, and then speed signalling would lose many of the advantages claimed for it in comparison with route signalling. After all, what are signals for but for the "Footplate"?

The American Society of Mechanical Engineers.

The preliminary meeting of the organisers of the American Society of Mechanical Engineers was held in the offices of the *American Machinist*, then in Fulton-street, New York, on February 16th, 1880, and on April 7th of the same year the Society was founded at a meeting in the Stevens Institute of Technology, Hoboken, N.J. Hence the jubilee of the Society fell on April 7th of this year, and to celebrate it a special convention, to which were invited representatives of other institutions and learned bodies from all parts of the world, was organised. It was a great regret to everyone that, owing to illness, Mr. Charles Piez, President of the Society was unable to be present at any of the many functions.

Members of the Society and the delegates assembled in New York on April 5th, when the first ceremony was the unveiling of a bronze tablet commemorating the fiftieth anniversary of the Society in the lobby of the Engineering Societies' Building. The tablet, which resembles the Fiftieth Anniversary Medal, was unveiled by Mr. C. E. Gorton, Vice-President, and a short address was delivered by Mr. C. T. Main, Past-President. Omnibuses then took the party to the McGraw Hill Building, where, after an address of welcome by Mr. Malcolm Muir, President of the McGraw-Hill Publishing Company, an amusing little sketch portraying work in the publishing and editorial office of the *American Machinist* in 1880 was presented.

The whole party was then taken in motor omnibuses through the Holland Tunnels to the Stevens Institute at Hoboken, where a pageant entitled "Control" was performed by students of the Institute. The pageant consisted of a number of short plays, each of which turned upon some notable event in the history of mechanical engineering. We saw Boulton forming his partnership with Watt, Stephenson fighting for the Liverpool and Manchester Railway in a Committee Room of the House of Commons, Faraday demonstrating the magneto-electric current in the Ashmolean Museum, the founding of the American Society of Mechanical Engineers, and finally the coming of electric lighting. The whole thing was very well done

and reflected great credit, not only upon Mr. George Pierce Baker, Department of Drama, Yale University, who wrote the book, and Mr. Harold Burris-Meyer, who produced it, but upon the numerous performers.

In the evening a welcoming dinner was given in the Roosevelt Hotel, with Mr. Charles Schwab as toastmaster. In America the toastmaster is a very important person; he presides over the dinner, and it is his duty to make a preliminary speech and subsequently to introduce each of the speakers in turn. It is impossible to imagine a better toastmaster of this kind than Mr. Schwab. After his own speech, which was very amusing, he called first upon Mr. Paul Doty, then upon Mr. Edward J. Mehren, and finally upon Mr. Robert I. Rees to deliver addresses. Here again there is a marked difference between American and British procedure. The addresses were carefully thought out and serious contributions to literature and occupied considerable time.

On Sunday a move was made to Washington, where on Monday morning, April 7th, the real Jubilee Celebrations opened in the Chamber of Commerce Building with a welcoming address delivered by Mr. Ralph E. Flanders, Vice-President of the Society. Thereafter the delegates from many nations—there were twenty-one on the list, but not all were present—offered the greetings of societies and universities of their own countries to the American Society, and one representative from each nation made a two-minute speech, Mr. W. H. Patchell being the speaker for Great Britain.

Amongst the steps taken to celebrate the jubilee was the preparation by a selected representative of each nation of a monograph dealing with the progress of engineering during the past fifty years in his own country, with some reflections upon the influence of engineering upon civilisation. These monographs, which, it is understood, will be published in due course, run from 8000 to 15,000 words in length, and

A.S.M.E. FIFTIETH ANNIVERSARY MEDAL

it was, of course, impossible that they could be presented in full, but on Monday afternoon and Tuesday morning summaries were read by as many authors as happened to be present. The British monographs were prepared and presented by Brigadier-General Charles H. Mitchell, Dean of the Faculty of Applied Science and Engineering in the University of Toronto, and Mr. Loughnan Pendred, President of the Institution of Mechanical Engineers. For the United States Dr. Carl E. Grunsky wrote the monograph and read the summary, but Dr. Fred Low also presented a report entitled "A Half Century of Progress in Mechanical Engineering in the United States," which forms a special number of *Mechanical Engineering*, and which was edited by Dr. Low, Mr. L. P. Alford and Mr. Roy V. Wright.

On Monday evening a dinner in honour of the medallists was given in the Cosmos Club, at which Mr. Ralph Flanders delivered an address, which we reprint on another page; and, later, a reception was held in the Mayflower Hotel by the officers and Council of the Society.

On Tuesday a Founders' luncheon was given in the ball room of the Mayflower Hotel, with Mr. Ambrose Swasey as honorary chairman and Mr. John R. Freeman as presiding officer. The living founders of the Society are Messrs. John W. Cloud, of London, England; John S. Coon, of Atlanta; Robert Grimshaw and Francis H. Richards, of New York; E. H. Robbins, of Pittsfield; and Ambrose Swasey, of Cleveland. A special medal had been struck in honour of these men and copies were presented to those who happened to be at the luncheon and to the representatives of the others. The presentation address was made by Mr. Robert L. Daugherty, and that veteran, Mr. Ambrose Swasey, who received a clamorous welcome, responded.

The company then reassembled in the Chamber of Commerce Building for a Convocation for the Conferring of Honours. The ceremony, which was carried through with much dignity, was borrowed from the similar ceremony in universities. The recipients of the medals sat in allotted seats in the auditorium, each of the foreign delegates being accompanied by the Ambassador or Minister of his country to the United States—his Excellency Vincent Massey sat beside Brigadier-General Charles H. Mitchell, and his Excellency Sir Ronald Lindsay beside Mr. Loughnan Pendred. On the platform Mr. Conrad Lauer, Vice-president of the Society, was accompanied by other officers of the Society and by four Marshals—Messrs. Kenneth H. Condit, Arthur M. Greene, Herbert L. Seward, and Roy V. Wright.

Mr. Conrad Lauer opened the proceedings by announcing that Fiftieth Anniversary Bronze Medals—illustrated herewith—with gold replicas, would be presented to a distinguished engineer of each country represented, the Daniel Guggenheim Medal would be handed to Mr. Orville Wright, the Gantt Gold Medal to Mr. Fred J. Miller, the A.S.M.E. Medal to Mr. Arthur M. Greene, jun., and the Melville Medal to Mr. Joseph Wickham Roe.

The foreign recipients of the medals were the authors of the monographs already mentioned, and the presentation was made by countries in alphabetical sequence. Two Marshals in their university robes approached the delegate and the chief diplomatic officer of his country, who was seated beside him. One Marshal led the officer up to the Chairman's right, whilst the other conducted the recipient to his left. The officer was then introduced to the Chairman by his Marshal, and he in his turn said a few words by way of introduction of the recipient. Mr. Lauer then, using a very well-drafted formula, handed a large bronze medal to the delegate, whose Marshal pinned the gold miniature on his coat. Both the introducer and the recipient were then led back to their places.

A somewhat similar procedure was followed in the presentation of the other medals.

The concluding function of the celebration was an Anniversary Dinner, held in the Ball Room at the Mayflower Hotel. On this occasion the toastmaster was Dr. William F. Durand, Past-president of the Society, and an address was given by Mr. Robert A. Millikan, on the Bonds between Science and Engineering. After it, Dr. Durand gave place to Mr. Dexter S. Kimball, also a Past-president of the Society, who called upon Mr. J. V. W. Reynders, Past-president of the American Institute of Mining and Metallurgical Engineers, to give an address, and Mr. Kimball then presented the Hoover Medal to Mr. Herbert Hoover, the President of the United States, who acknowledged the gift in a short speech. The Hoover Gold Medal was instituted to commemorate the civic and humanitarian achievements of Mr. Hoover. From time to time it will be awarded by engineers to a fellow-engineer for distinguished public service. The trust fund, which is the gift of Mr. Conrad N. Lauer, of Philadelphia, is held by the American Society of Mechanical Engineers, and is administered by a Board of Award, consisting of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

On the following day, after visits to places of interest in the neighbourhood, the members and visitors were received by President Hoover in the White House.

The Anniversary Dinner, honoured by the presence of the President of the United States and Mrs. Hoover, brought to a fitting conclusion a Jubilee which was marked throughout by dignity and by a sense of the serious part which the American Society of Mechanical Engineers plays in the promotion of civilisation in the United States, and the influence exercised by mechanical engineering on the prosperity and progress of humanity in all the great nations of the world. There were no technical papers, no discussions, but, throughout, the larger view of engineering, to which the technical details only contribute, was taken. In all the speeches, addresses, and monographs, the civilising aspects of engineering were kept to the fore. We desire to congratulate the organisers of the Convention on their selection of this standpoint. Engineering in all its branches is the most powerful influence at work in the world to-day. Although its acts are apparently only of a materialistic kind, no one can doubt that it is having also an intellectual effect. Its influence upon sociological tendencies cannot be neglected; it has made and is making a new world; the thoughts and aspirations of all peoples are modified by it; it has opened a new medium for intellectual inquiries, and is directing philosophy into new channels. There may be much in it to criticise; something to regret; but the fact remains that a world without engineering is unthinkable. In such circumstances, it was indeed a great thought to devote this international Convention to a consideration of the influences which it is exerting upon humanity, the rise of that influence in the past fifty years, and its promise for the future of mankind.

SIXTY YEARS AGO.

WE have on previous occasions commented on the freedom of criticism permitted to the Press in past years before the laws of libel became as rigid and defined as they are to-day. In common with other journals, we at times made full use of our opportunities in this respect. Witness, for instance, the leading article entitled "The Ministerial Whitworth Job," which we published in our issue of April 29th, 1870. We began by attacking the Government. It claimed, we said, to be the very incarnation of invulnerability, justice, realism, truthfulness, progress and economy. Its actions, however, we contended, falsified every one of its claims to righteousness. Plainly we did not like Mr. Gladstone. Equally plainly our succeeding remarks showed that we did not like Sir Joseph Whitworth and the Government's dealings with him. We accused the Government of having yielded to Sir Joseph's importunity for the sake of the political influence which he commanded in the Manchester district. He and his supporters had, it was unofficially reported, "succeeded in extracting" from the Government an order for a 35-ton naval gun. Our indignation at this report knew no bounds. For Sir Joseph's sole benefit the Government, we wrote, was about to recommence experimenting with an exploded system of artillery, the public trials of which had previously cost the nation nearly £100,000 and had ended in a verdict of complete condemnation. "For the sake of the worthless and exaggerated political aid which the Whitworth clique was assumed able to withhold or give," the taxpayer's money was now to be absolutely wasted to the extent of an additional £50,000 at least. The reasons against such a procedure were, we said, patent to every honest man who was acquainted with the Whitworthian small-arm and artillery career from its commencement. They are less patent perhaps to the modern reader, compelled to rely on the evidence embodied in our article. It would appear that during the Crimean War Sir Joseph obtained £10,000 from the Government wherewith to build a "shooting gallery" for himself. After some years of mysterious experiments he arrived at results which were claimed to have advanced our knowledge of rifled firearms by several centuries, but which, we contended, any competent mechanic could have reached without a single experiment. Seven years followed of further experimentation. Then came the great trial between the Whitworth and the Armstrong systems of artillery, which ended in the opinion of every unbiassed judge in an unmistakable verdict against Sir Joseph. "The Story of the Guns," a book subsequently published in support of his system, consisted, we wrote, of garblings and falsehoods and would forever remain a stain on the memory of its author. The sole excuse for the revival of the Government's interest in Sir Joseph's system which we could find was in his alleged development of a new metal, referred to by some as "compressed steel." Three projectiles of this new material had, we reported, been recently fired at Shoeburyness. One had gone partially through the target; another broke up on striking it; the third broke up in or at the mouth of the gun. We trusted that Sir Joseph and his Whitworth Gun Company would be prevented from again getting their fingers into the national coffers. If the job was to be done, we hoped that it would not be done without due exposure. The invective of our article reflects the intensity of the feelings which prevailed in the "battle of the guns" and the freedom with which the contending parties expressed their opinions about the personalities of their opponents and the merits of their systems.

CO-OPERATION IN A SCIENTIFIC INDUSTRY.

SOME twelve years ago, in order to improve and give impetus to a trade that had fallen to a very low level, the drawing-office material manufacturers and dealers of Great Britain came together and formed themselves into what is now known as "The Drawing Office Material Manufacturers' and Dealers' Association." This Association comprises the whole of the firms originally connected with the industry, many of them bearing household names with world-wide reputations. It is felt that, although great advances in technical processes have been attained by the manufacturers themselves acting in harmony, still further progress could be made if the co-operation of the actual users of the various commodities could be secured. Difficulties may be experienced by the practical engineer and draughtsman which do not suggest themselves to the scientific adviser of the manufacturers, but which, if the problem were presented to him, he might be able to solve. The Association has, therefore, established a permanent Committee whose sole duty is to ascertain in what way this industry can help to increase the efficiency of the drawing-office, and the principal engineering firms of this country are being invited to co-operate by notifying the Association of any matter in connection with their drawing-offices wherein the collective experience of the Association might be of assistance.

We understand that firms approaching the Association place themselves under no obligation of any kind. This ingenious scheme represents an attempt to secure by organisation information which can now be obtained only fortuitously in a haphazard manner. If it proves successful its work should be beneficial to all, and we shall watch its progress with interest.

The International Railway Congress.

No. I.

THE International Railway Congress is probably, in its constitution and representation, the most international in character of all such bodies. Its delegates are drawn not only from railway administrations, but from governments. From a report presented to a meeting of the Permanent Commission, or governing body, held in June, 1928, it appears that 225 administrations operating railways are members, and that they possess a total mileage of 325,375.

The Congress used to meet at intervals of five years. It was not until the London meeting in 1895 that it became established on a wide and firm basis, and the next meetings were in Paris in 1900, Washington in 1905 and Berne in 1910. The next was to have been held in Berlin in 1915, but owing to the war there was a lapse of twelve years, and the next Congress, after a futile effort to get it ready for 1920, took place in Rome in 1922. Because of the desire to meet in London in 1925, and thus to be associated with the Railway Centenary, there was an interval of only three years after Rome. This year the eleventh session of the Congress meets in Madrid on May 5th, and the next Congress will be in 1933 at a place to be then decided.

Each government or railway administration, being a member of the Congress, is entitled to send delegates thereto, the number being determined by the length of the railways owned. The meetings are divided into the following five sections:—(1) Civil engineering; (2) mechanical engineering; (3) operation; (4) statistics, staff and general, and (5) light railways. Usually these sections meet separately, but when a report that is of interest to two sections is to be considered there may be a meeting in common.

Generally there are twenty subjects to be discussed. They are selected by the Permanent Commission some three years or so in advance and reporters are appointed to deal with them. Three reporters are, as a rule, appointed on each subject and each is given selected countries to cover. Questionnaires are sent out to the administrations and the reporters are than furnished with the replies. The reporters are always men of the highest standing on their particular system and are authorities on the subject to be dealt with. A feature almost peculiar to the Railway Congress is the freedom with which valuable information is given upon subjects which, ordinarily, railway officers are reluctant to say anything about.

The reports have to be completed and in the hands of the Permanent Commission about twelve months before the Congress, and they are then printed and distributed to the administrations. The present Congress has earned distinction by the early appearance of the reports.

It is a source of great satisfaction, and will be very helpful to the success of the Congress, that, for the first time, the German Government and its railways will be represented, not only by delegates, but by reporters, at Madrid. The request to be allowed to join the Association was granted to Germany at the Berne Congress in 1910, but that country was not, of course, present at Rome. At London, in 1925, the invitation was renewed, and on July 6th last it was announced that it had been accepted.

For the Madrid meeting there are twenty subjects for reports. They are:

I. The use of concrete and reinforced concrete on railways: (*a*) investigation into the respective merits of the different designs of concrete sleeper; (*b*) concrete and reinforced concrete buildings. II. Resistance of rails against breakage and to wear: (*a*) first causes of rail breakage; measures taken to reduce the number of breakages, both as regards the way in which rails are used and the conditions of inspection; (*b*) quality of metal used for rails to give normal wear, conditions governing manufacture and inspection, profile and quality, length, weight and cross section of the rails; (*c*) the most economical and efficient design of rail joints. III. Investigation into the static and dynamic stresses in railway bridges. IV. Recent improvements in permanent way tools and in the scientific organisation of maintenance work. V. Locomotives of new types, in particular, turbine locomotives and internal combustion motor locomotives: construction, efficiency, use, and repair. VI. Improvements in the steam locomotive: increased pressures and higher superheats; improvements in the design of superheaters and parts connected with superheating; feed-water heating and air preheating; improvement of valve gears. VII. Electric locomotives for main line traction: (*a*) passenger locomotives; (*b*) goods locomotives; (*c*) locomotives for mountainous country; multiple unit traction. VIII. All-steel coaches, comparison with vehicles built of wood. IX. Relations between railways and seaports: lay-out of maritime stations, arrangement of outer and inner basins so that the most efficient lay-out of sidings may be provided for working them, operating and rate-fixing methods, loading and discharging appliances. X. Methods to be used in marshalling yards to control the speed of vehicles being shunted and to ensure that they travel on to the lines in the various groups of sidings. XI. Signalling of lines for fast traffic and in main stations; daylight signals; automatic block system. XII. Economical traction methods for use in particular cases: (*a*) organisation of train services on the minor lines of the large systems carrying little traffic and of little used trains on the more important lines of those systems; (*b*) use of special tractors for shunting in smaller yards and for certain work in large yards. XIII. Competition of road transport: effect of road competition on goods and passenger traffic and the best methods of meeting such competition, both as regards the main lines and the branches. XIV. Use in railway work of machines for simplifying statistical and accountancy work. XV. Co-operation of the staff towards increased efficiency and its participation in the profits. XVI. Methods followed in training of staff: professional, technical, and ordinary working grades. XVII. Penetration railways: (*a*) in new countries; (*b*) feeder railways in all countries. XVIII. Improvements in the permanent way equipment of light railways. XIX. Electrification of secondary lines. XX. Rail motor vehicles.

In anticipation of the opening on May 5th of the Madrid meeting, we shall give, in the following series of articles, summaries of those reports which are of particular interest to engineers.

SUBJECT I.—USE OF CONCRETE AND REINFORCED CONCRETE ON RAILWAYS.

Three reports have been submitted on this matter. Report No. 1 is made jointly by M. Jullien, the engineer-in-chief for the permanent way and works of the Paris-Orleans Railway, and M. Claise, the director in control of works on new railways for the French Ministry of Public Works. The countries covered are Belgium, France, Italy, Portugal, Spain and their Colonies and Switzerland.

That part of the report which deals with (*a*) "Investigation into the Respective Merits of the Different Designs of Concrete Sleeper," opens by quoting the following conclusions arrived at after the discussions on the same subject at the Rome Congress in 1922:

> "In regard to railway equipment, it is desirable that the results of trials which are being carried out by various administrations of the use of reinforced concrete sleepers should be recorded. The latter may form a valuable adjunct to the supply of wooden sleepers and in that will help to regulate their price."

The various reports at Rome showed that the trials which had been made up to that time had met with little success, especially those carried out by the Italian State Railways, where 300,000 reinforced concrete sleepers were orginally put into use on main lines and had to be taken up and laid in station yards. At the same time one of the reporters dwelt on the more encouraging results which had obtained in France with the Vagneaux and Calot sleepers. The Rome reporters recommended the following improvements, which have since been carried out:—(*a*) Substitution of a hardwood treenail for the cast iron bush used in the Calot sleeper to take the coach screw; (*b*) interposition of a wooden packing between the sleeper and the bottom of the rail; (*c*) complete suppression of tamping under the centre portion of the sleeper.

From the tables in the present report, which are based on replies from the various railway systems in the countries covered, it appears that on the Italian State Railways the above-mentioned 300,000 reinforced concrete sleepers, known as the F.S. XI., were laid between 1907 and 1913 and that 170,000 F.S. 1925 pot-sleepers were being made. On the Nord of France 41,550 Calot modified and 10,200 Calot pot-sleepers had been laid since 1926. On the Paris-Orleans there had been in use since 1909, 140,000 Calot sleepers, and 60,000 Calot pot-sleepers were being laid. The Nord had also had in use since 1926, 7350 sleepers of the Vagneaux type and 2150 Vagneaux pot-sleepers. The Paris, Lyons and Mediterranean had in service 24,000 Vagneuax sleepers, of which it is said that "although these appear up to now to be technically satisfactory the inventor continues to try out new improvements, notably with regard to the rail fastening."

Good accounts are presented by the Paris-Orleans as to the Calot sleeper, but it appears that on curves of small radius there is a tendency for the gauge to widen until it reaches an excess of $\frac{1}{4}$in. to $\frac{5}{16}$in., after which it remains constant. The same administration reports, in reference to the cost, in comparison with wooden sleepers, that the installation of works for mass production on a large scale in the neighbourhood of a river, from which supplies of sand and gravel could be taken without transport cost, would reduce the price of the concrete sleeper below that of the wooden one.

Part (*b*) of Report No. 1 relates to concrete and reinforced concrete buildings. Therein Messrs. Jullien and Claise record that no important modification has taken place, since the Rome Congress, in the art of building with this material. It is remarked that when Mr. W. W. Grierson reported on this subject to the Rome Congress in 1922, he said, in relation to underbridges, that the suitability of reinforced concrete for that purpose had yet to be demonstrated, save possibly for quite small spans, and that for large spans its adoption must be approached with caution. The conclusions of the Congress, however, modified that opinion, as it recorded:

> "For railway bridges which are subject to dynamic forces there appears to be no technical reason against the use of reinforced concrete, which can frequently be used advantageously, but requires very close supervision in its execution."

The present reporters have, therefore, endeavoured more particularly to bring out the progress that has been realised in construction work in concrete—reinforced or not—underbridges. Mention is made of the benefits following the use of quick-setting cement and of high-tensile steel, and a description is given of new methods of construction; the use of pin joints to reduce secondary and parasitic stresses and the introduction of systematic deformations before striking the centres or when doing this work.

The conclusions of the reporters are that if progress has been made it is in road bridges and in railway bridges of small span; the use of concrete and reinforced concrete in railway bridges of medium or long span is quite exceptional. "That type of structure appears, none the less, likely to develop, and the use of super-cements and of modern methods of construction that we have related cannot fail to facilitate this development. On the other hand, it has been found that many structures in reinforced concrete show more or less serious damage as a result of the action of smoke."

Report No. 2 on the subject of the use of concrete and reinforced concrete is dealt with by Mr. F. B. Freeman, the chief engineer of the New York Central Railroad. It covers America, the British Empire, China and Japan.

Mr. Freeman presents a very pessimistic report under part (*a*). It opens by commenting on the progress since the Rome meeting, and observes that:—

> "Experiments have been continuous and much study given in various parts of the world covering the subject of reinforced concrete sleepers. Those experiments have covered many different designs, of which only a few have been satisfactory from a physical standpoint, though length of service is insufficient to draw definite conclusions as to life, and none are recommended for general use, due to high cost. It is apparent that these experiments and studies have failed to develop a reinforced concrete sleeper which can be considered satisfactory or which can hope to compete with the treated wooden sleepers now so universally used."

Reports are presented from twenty-five railway systems, of which seventeen are in the United States, three in the United Kingdom, and two in India. Only three out of the twenty-five reports are "Satisfactory," and those reports, we notice, cover only a total of 269 sleepers. Six present no conclusions and sixteen are "Unsatisfactory." The main objections to reinforced concrete sleepers, in addition to their high cost, seems to lie in their failure to withstand the shock and vibration of heavy traffic, the failure of the fastenings, lack of insulation between way and sleeper, together with gradual weathering and disintegration of the concrete.

Mr. Freeman mentions that in the new station in Buffalo there is a concrete road bed in all the station tracks which has been installed, primarily for sanitary reasons, to facilitate cleaning and reduce maintenance cost. His report concludes:—

> "Experiments are being continued covering the sleeper construction as well as the reinforced concrete road bed, and it is believed that in the light of past experience a satisfactory design will be evolved. It appears, however, that the use of such construction will have to be for other reasons than economy, except in a few countries where wooden sleepers are scarce or relatively more costly."

In reporting on the second heading of this subject, Mr. Freeman says that considerable progress has been made in the general use of reinforced concrete for building construction on railways since the Rome meeting. The increase is due largely to the general desire to secure buildings of more permanent construction, to reduce maintenance and to eliminate fire hazards. Improvements in materials and in methods of construction have played an important part.

Among the replies received from the various railway systems, we notice that the London and North-Eastern Railway considers reinforced concrete suitable for building construction on account of durability, low maintenance cost, fire-resisting properties, better distribution of loads on foundations, and for marine work subject to destruction by marine worms. We observe also that the Metropolitan Railway does not generally advocate the use of reinforced concrete for the whole of a building because of the slowness of the work, extensive amount of shuttering required, and the difficulty and cost of any subsequent alterations. Present practice on that railway is to use reinforced concrete for floors, staircases and flat roofs, for which it is considered advantageous.

In the United States permanence, reduced maintenance, and fire resistance have been the main reasons for its use. In general, the first cost is somewhat higher at the present time than for steel-frame and brick buildings, though there are cases in which reinforced construction is cheaper. The objection to the use of reinforced concrete construction is the difficulty, and high cost, of making alterations, but this objection is not serious where alterations are not likely to be required or if ample provision is made for future needs.

Mr. Freeman's report sums up the question by saying:—

> "The cost of such buildings, however, has often been found to be greater than combinations of steel-frame and concrete or brick. Nevertheless, the value of concrete and reinforced concrete for floors and platform construction and as a fire-resisting material is universally recognised. Some failures are reported, but these are, in general, due to improper designs, improper materials or poor workmanship, and it is noted that in the more recent installations these features are being given more careful consideration. Dense concrete, secured by control of water-cement ratio and of grading and regulation of the mix, is of prime importance, and it is generally felt that greater strength, permanence, and serviceability can be obtained along those lines."

The third report on the subject of concrete and reinforced concrete is by Mr. E. Krick, an inspecting officer at the headquarters of the State Railway of Yugoslavia, and deals with all the other countries not covered by Reports Nos. 1 and 2.

Mr. Krick's report covers practically only structures

in concrete. Reinforced concrete sleepers are, it is true, mentioned, but are dismissed thus :—

"In view of the insufficient information upon the use of reinforced concrete sleepers on the railways dealt with in this report, we have not been able to formulate any conclusion upon the advantages or drawbacks, whether economical or practical, of this form of construction."

The report then proceeds to deal in detail with various features. Of these, the question of locomotive depôts is of general interest, particularly as to the effect of smoke. Mention is made of several round and rectangular houses, and the report observes, as regards smoke, that :—

"Most of the administrations prefer to get rid of the smoke locally. When it is evacuated centrally by concrete smoke jacks, opinions upon the extent of the destructive action of the smoke upon the concrete are divided. Several of the administrations have, however, fitted their sheds with central jacks in concrete. . . . In any case, it is desirable to maintain in good state the smoke jacks, and that these latter should be given some protecting coat against the action of the combustion gases.

"Owing to the great differences of temperature to which the jacks are exposed, it is necessary to allow for changes in length, and to see that by a suitable arrangement of the jacks when building locomotive sheds, their free movement is not hindered, so that harmful stresses shall not be set up in the different parts of the structure."

In his summary Mr. Krick makes the important point that :—

"When it is a question of building structures in reinforced concrete for railway purposes, there is one essential point which must not be neglected. The railways are comparable with living organisms, which must adapt themselves to the changes of an economic and commercial kind by extending their installations by reconstructions, &c. Now the demolition of reinforced or ordinary concrete structures is not only more difficult than those of other materials, but give material without value and difficult to dispose of. It is therefore necessary before deciding to build a structure in ordinary concrete or in reinforced concrete upon or near to railways to examine the whole of the possibilities of rearranging or extending the station, so that the structure has not to give place to others in the neag future."

The summary contains also the following interesting observations as to tests that were made on the Southern Railway of Austria to ascertain the effect of locomotive smoke on concrete structures :—

"These test pieces were taken at points where the smoke had exercised a considerable action. It was found that the layer of soot was confined to the surface, that the metal reinforcements and even the thin binding wires were intact, the tests with these wires did not reveal any molecular transformation of the iron, that the concrete had not been attacked chemically by the smoke, and that the presence of sulphurous acid, sulphuric acid, and carbonic acid was not discernible, except in the outside 1 cm. layer of the concrete. In view of these results, the conclusion was come to that a coating in concrete, 3 cm. thick, was sufficient to guarantee the reinforcement against the action of the smoke, provided the concrete was as compact as possible."

SUBJECT II.—RESISTANCE OF RAILS AGAINST BREAKAGE AND TO WEAR: RAIL JOINTS.

Three reports are presented on this subject. They are divided into (*a*) First causes of rail breakage; measures taken to reduce the number of breakages, both as regards the way in which rails are used and the conditions of inspection; (*b*) quality of metal used for rails to give normal wear; conditions governing manufacture and inspection; (*c*) the most economical and efficient design of rail joints.

Report No. 1 is by Mr. R. B. Abbott, assistant general superintendent of the Philadelphia and Reading Railway, and applies to America only. The author records that experiments are now going on with heat-treated rails and with rails having abnormal proportions of manganese and other hardening elements. The heaviest rail used in America is the 135 lb. Lehigh Valley section. Sections of 130 lb. predominate on heavy traffic lines. Most roads use rails 39ft. long to eliminate or reduce the number of track joints within the limits of road crossings and station yards; rails 66ft. long are used by several roads. Long rails result not only in economy, but also in better riding track.

The only change of importance made in America in this relation, since Mr. W. C. Cushing, of the Pennsylvania Railroad reported to the London Congress of 1925, that Mr. Abbott has to record is the development of the head-free angle bar—fish-plate—and head-free rail, as used on the heavy-duty tracks of the reporter's railroad. Of the angle bar it is said :—

"Prior to the development of the head-free angle bar, it had always been considered an essential of design that a clearance of about $\frac{1}{8}$in. should be provided at top and bottom, between the sides of the angle bar and the web of the rail. This clearance was deemed essential to provide take-up for wear. The top of the angle bar pressed against the underside of the rail head, and this was also considered an essential of design.

"However, the head-free angle bar does not give head support to the rail, except in the area comprised by the fillet where the head joins the web. Necessary clearance for take-up is afforded at the bottom of the bar. This take-up at the bottom of the bar, together with the fact that the bar has a positive bearing at the top, constitutes the reasons for its greater strength and resiliency."

The head-free rail followed. A certain amount of metal was taken from the lower corners of the rail head and added to the top, thereby making the rail $\frac{3}{16}$in. higher and increasing the strength as a beam something over 5 per cent., as compared with the 130 lb. American Railway Engineering Association section. The area of wear has been increased by at least 25 per cent., and, on the high side of curves, that section will not wear to a shelf. It is considered that the new head is obviously a better design from a rolling standpoint.

In contrast, as regards its length, with the report by Mr. Abbott—which has only three pages of matter and two of illustrations—comes Report No. 2 by Messrs. Cambournac and Patte, of the French Northern and Eastern Railways respectively, which fills exactly 100 pages. It covers all countries except America, the British Empire, China and Japan.

Faced with such a lengthy report, we can only deal with the conclusions of the reporters. Breakages and defects in rails in service, they say, continue to be carefully investigated by the railway companies, either alone or in collaboration with the manufacturers. The value of this investigation cannot be too strongly stressed, even if it does not lead to any immediate and well-defined conclusion. It is considered most desirable to co-operate with the metallurgists, as is done, for example, in France. As a result of such investigations several railway companies have stiffened their specifications with a view to avoiding rails with segregation and, more particularly, by adding macrographic tests.

Investigations are still being made with a view to obtaining less brittle rails. Mention is made of the increased use of heat-treated rails in France as a result of what are referred to as the remarkable tests carried out by the Neuves-Maisons Works, which showed how much an appropriate heat treatment could increase the strength of rails against the development of superficial fissuration, caused by the slipping of locomotives—see THE METALLURGIST, Vol. IV., 1928.

Report No. 3 is by Dr. S. Matsunawa, Chief of the Railway Research Office of the Japanese Government Railways, and covers the British Empire, China and Japan. It is longer even than Report No. 2, as it fills 120 pages, but thirty-seven of them are devoted to two appendices, on the subject of the transverse fissure of rails and on a rapid method of determining endurance limits by means of measuring electrical resistance, which have been furnished by Mr. Shoji Ikeda, of the Railway Research Office.

Unfortunately, Dr. Matsunawa does not lay down any conclusions arrived at as a result of the reports he has received. In looking through the replies to his questions we find it recorded that the largest number of rail failures take place between ten and twenty years after laying. On the Great Western of England the failures, however, do not occur until between twenty-five and thirty years after the rails have been placed in service. In the reporter's opinion that is accounted for by better track maintenance on that system as a whole than on other railways.

It is also recorded that whilst 26·4 per cent. of the entire track length of the Japanese Government Railways is laid on gradients of 1 in 100 and over, the percentage of rail breakages on gradients was 33·6 per cent., which shows a comparatively large number in such situations. Furthermore, 19·7 per cent. of the length of the whole line is on curves of 40 chains or less. The breakage ratio on curves was 27·1 per cent., which shows that there are more failures on a curved line than on a straight.

Breakages occurring at fish-plates number from 8 to 50 per cent. of the total rail failures, which suggests to the reporter that the number of joints should be as small as possible and that greater care should be taken in the design, manufacture and maintenance of joints.

As a result of a question as to a study of transverse fissures as a cause of rail breakage, the reporter says that whilst such breakages must be experienced by all railways, no close investigations have been reported. The subject is being much discussed among the American railway engineers.

Under sub-heading (*b*) it is reported that rails of special steels, now experimentally in service on various railways, are made of manganese, chromium and silicon steels and, for heat-treated steel rails, Sandberg's sorbitic rails are being tried.

The London and North-Eastern reports that the life of chrome steel and manganese steel rails is 1·2 times and 3 to 4 times respectively as long as that of the ordinary carbon steel rail. Sorbitic steel rails are also being tried. The London, Midland and Scottish Railway is trying rails of manganese, chrome and sorbitic steel. The Southern Railway considers that rails of rolled manganese steel are preferable at points and crossings where the rails are subject to unusual wear; their life being from four to six times that of high-carbon steel rails in similar positions. The life of chrome steel rails, with about 1 per cent. chromium, is probably more than twice that of the ordinary steel, but evidence of brittleness has been noted. The same company reports that investigations of British standard section rails of higher carbon Bessemer steel, heat treated by the sorbitic process, are not yet complete.

On the New South Wales Government Railways abrasion tests were carried out on rails of special steel and of ordinary carbon steel at several places where the wear is rapid. The results show that the manganese steel rail is the best, followed by the silicon, and that the nickel steel rail is rather inferior to the ordinary carbon steel rail. On a curve 12 chains in radius, under the same traffic conditions, the sorbitic steel rail was tried. Though it was not as good as the manganese steel rail, it had higher abrasive resistance than ordinary carbon steel rails. Experiments with Sandberg's sorbitic rails have been carried out with good results on the South African Railway.

From Dr. Matsunawa's own railways—the Japanese Government—there is an interesting and full record. It shows that rolled and cast manganese steel rails were laid at points and crossings subject to rapid wear, and that comparison was made with ordinary carbon steel rails. The result proved that the former have an average life of about five or six times that of the ordinary carbon steel rails and that their use is economically justified.

Comparative investigations were made of the manganese steel rail of 74·6 lb. per yard, and the ordinary carbon steel rail of the same weight which were laid in alternate lengths on a line of 15 chains radius over which electrically operated trains run. The object was to discover the economic and other advantages of rolled manganese steel rails when compared with carbon steel rails. As to hardness, the manganese steel did not show much difference in the initial state, but subsequently the Brinell hardness of the manganese steel rail rapidly increased and finally reached about 500. That of the carbon steel rail also increased, but only gradually, and did not exceed 300.

The wear of the outer rails where manganese steel was used was 1 per cent. during 100 days in service, whilst the carbon steel rail lost 4·8 per cent. during the same period.

The tests further showed that the manganese steel rail must be renewed after the passage of 27,799,000 English tons, but the carbon steel rail must be renewed after 4,375,800 tons. In other words, the life of the former is 6·4 times as long as the latter, *i.e.*, 32 months against 5 months. If the initial costs, renewal expenses and the rate of interest are taken into consideration, the life of the manganese steel, as compared with the carbon steel rail is required to be at least 28 months, *i.e.*, 5·6 times as long. Thus the former has an advantage of durability over the latter by 4 months, and consequently the use of manganese steel rails may be recommended on curves of 15 chains or less in radius.

Experiments on the same railway show that so far as the combination of rail and tire is concerned the most economical method is to increase the hardness of the tire by adding to its carbon content and, at the same time, to increase the carbon content of the rail in order that it may be the same as that of the tire.

(To be continued.)

VERTICAL RETORTS FOR GAS MAKING.

THERE are not many industries that have made greater progress during the last twenty years or so than that of gas manufacture. The process of carbonisation has been vastly improved and the continuous vertical retort is now responsible for between 50 and 60 per cent. of the gas produced in this country. The continuous vertical retort enables gas engineers to take full advantage of the greater freedom in manufacture which was conferred upon the industry by the Gas Regulation Act to make and distribute gas of whatever quality is most remunerative in any particular locality and under any particular conditions in the coke market.

A good deal of literature on the subject of coal gas manufacture has become available in recent years and a book which has just been published by the Wests' Gas Improvement Company, Ltd., of Manchester, will be welcomed by all who are interested in this important subject. This volume of over 230 pages gives a complete *résumé* of the results obtained with practically every kind of gas-making coal in the Glover-West vertical retorts installed in works in many parts of the world. The tests have in the main been carried out on a complete research plant belonging to the company, embracing a 40in. retort and auxiliary apparatus capable of dealing with 300,000 cubic feet of gas per day. In connection with this plant there is a large laboratory which is fully equipped with all modern apparatus for the analysis of gas, coal, coke, tar, &c. In this laboratory many series of tests on British and foreign coals have been carried out and the results are published for the first time in this volume. This information should prove most valuable to gas engineers.

An interesting feature of the book is the publication of a series of tests which were carried out over an extended period in the research plant to demonstrate the extent to which "steaming" can be successfully conducted, and we believe it is the only complete series of tests of the kind on exactly the same coal and under exactly similar conditions, so that the results are strictly comparable one with another. The gas made had calorific values varying between 360 B.Th.U's and 500 B.Th.U's per cubic foot gross and the respective yields of gas, coke, tar and ammonia are given in tabular form. A detailed examination of the coke produced in these tests, which were carried out in a continuous vertical retort, yielded particularly instructive results with regard to ash content. The tests show that the action of the steam can only affect the outside of the individual pieces of coke and that the increase in ash should only be felt in the breeze. The figures given show that on tests of Wigan Arley coal the amount of breeze produced varied from 7·9 to 22·3 per cent. as the calorific value of the gas was reduced from 503 B.Th.U's to 360 B.Th.U's per cubic foot, while the ash increased from 18·8 to 34·40 per cent.

Another useful feature of the book is the section giving results of a series of tests of coals from Chile, Australia, America and Czechoslovakia. The returns of a number of the principal gasworks are also given in tabular form, and altogether the information presented will be found most useful for checking working results and estimating gas yields at any calorific value which can be expected from most of the standard coals.

THE imports of electrical goods, excluding machinery, into the Irish Free State during February last amounted to £41,492, bringing up the total for the first two months of the year to £91,497, as compared with £71,690 in the corresponding period of 1929.

Causes and Prevention of Vibration in Motor Ships.*

By ROBERT SULZER.

THE question of vibration is one of great importance, particularly in the construction of passenger ships. Vibration in the machinery reduces its reliability; vibration in the ship itself is generally found very annoying by the passengers and may seriously affect the success of the vessel.

In this paper, attention will first of all be devoted to torsional vibration in the crank shafts and intermediate shafting. Fig. 1 shows the shaft system of a four-cylinder, two-cycle engine with short intermediate shafting, such as is usual in tankers. Below the actual shaft is drawn the equivalent shaft, of uniform diameter throughout, and with the masses of the running gear, flywheel and propeller reduced to the crank radius. This ideal shaft in its several sections has exactly the same elasticity as the actual shaft, and is used to simplify the calculation of the critical speeds.

The system can be set into torsional vibration under the influence of the harmonic forces from the tangential pressure of the working cylinders and the tangential resistance of the propeller. The vibration may have one, two or three or more nodes, as is shown by the forms of vibration shown in the drawing. To each of these forms of vibration there corresponds a definite frequency, which is determined by the size and distribution of the masses and by the elasticity of the shaft connecting them and can be accurately calculated. Synchronism occurs when the frequency of a harmonic force, *i.e.*, the product revolutions per minute multiplied by the order of the force, coincides with a natural period of vibration of the system.

Fig. 2 shows the harmonic analysis of the tangential-force diagram of one two-cycle working cylinder for full-load condition.

Any periodic function is equivalent to the sum of a constant term and certain sine functions of the time. The method usually adopted for determining the individual harmonic components of a periodic function is that developed by Fournier. In Fig. 2 the constant term is represented by the mean tangential force (T_m=2·31 kg./cm.² piston area) and illustrate the work done by the cycle. The sine curves drawn below do not represent any work, as the positive and negative areas are all equal; but when the ordinates are added to the constant term they give a true copy of the tangential force diagram. The additional torsional stresses, and with them the importance of these different orders, are determined by the variable force Δt, which, for instance, is 6·01 kg./cm.² of piston area for the first order and 0·209 kg./cm.² only for the 8th order, in the example shown in Fig. 2.

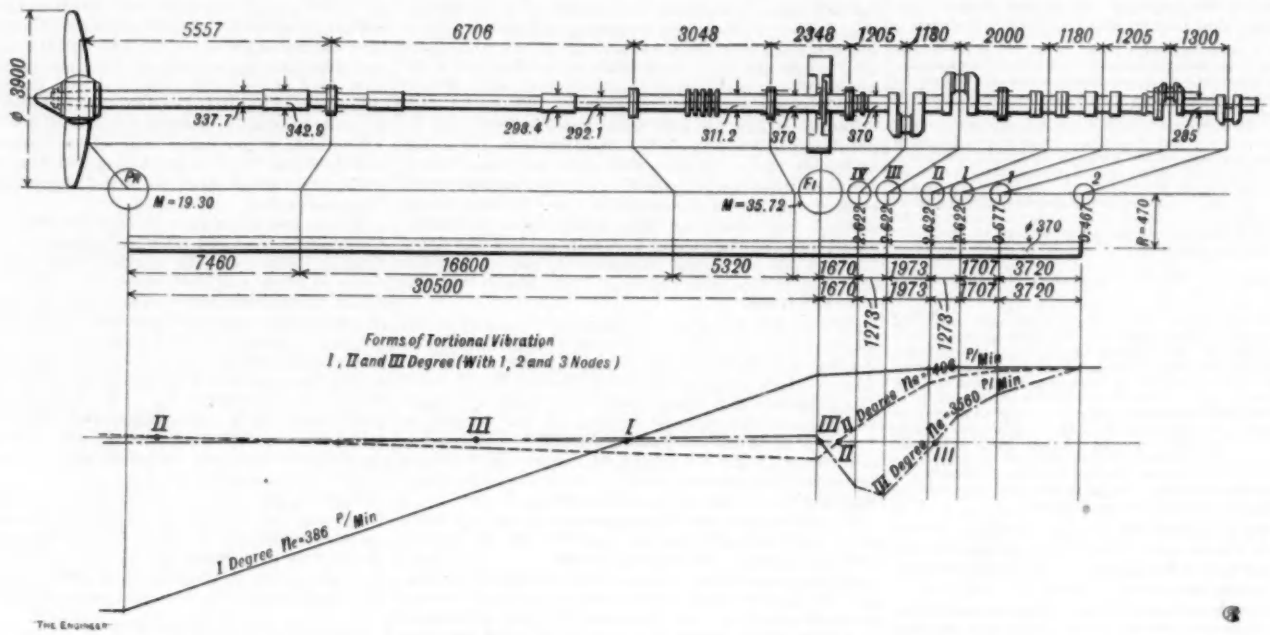
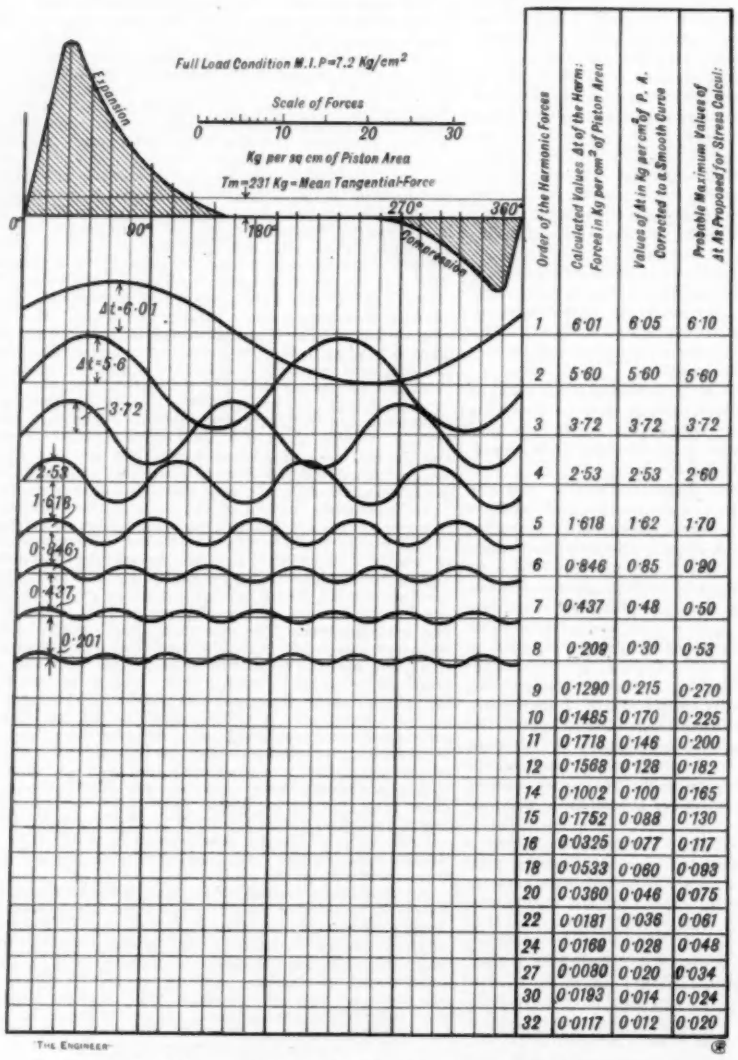


FIG. 1—FORMS OF TORSIONAL VIBRATION FOR A 4-CYLINDER, 2-CYCLE MARINE INSTALLATION



Order of the Harmonic Forces	Calculated Values Δt of the Harm: Forces in Kg per cm² of Piston Area	Values of Δt in kg per cm² by P. A. Corrected to a Smooth Curve	Probable Maximum Values of Δt As Proposed for Stress Calcul:
1	6·01	6·05	6·10
2	5·60	5·60	5·60
3	3·72	3·72	3·72
4	2·53	2·53	2·60
5	1·618	1·62	1·70
6	0·846	0·85	0·90
7	0·437	0·48	0·50
8	0·209	0·30	0·53
9	0·1290	0·215	0·270
10	0·1485	0·170	0·225
11	0·1718	0·146	0·200
12	0·1568	0·128	0·182
14	0·1002	0·100	0·165
15	0·1752	0·088	0·130
16	0·0325	0·077	0·117
18	0·0533	0·060	0·093
20	0·0360	0·046	0·075
22	0·0181	0·036	0·061
24	0·0169	0·028	0·048
27	0·0080	0·020	0·034
30	0·0193	0·014	0·024
32	0·0117	0·012	0·020

FIG. 2—HARMONIC ANALYSIS OF TANGENTIAL FORCE DIAGRAM

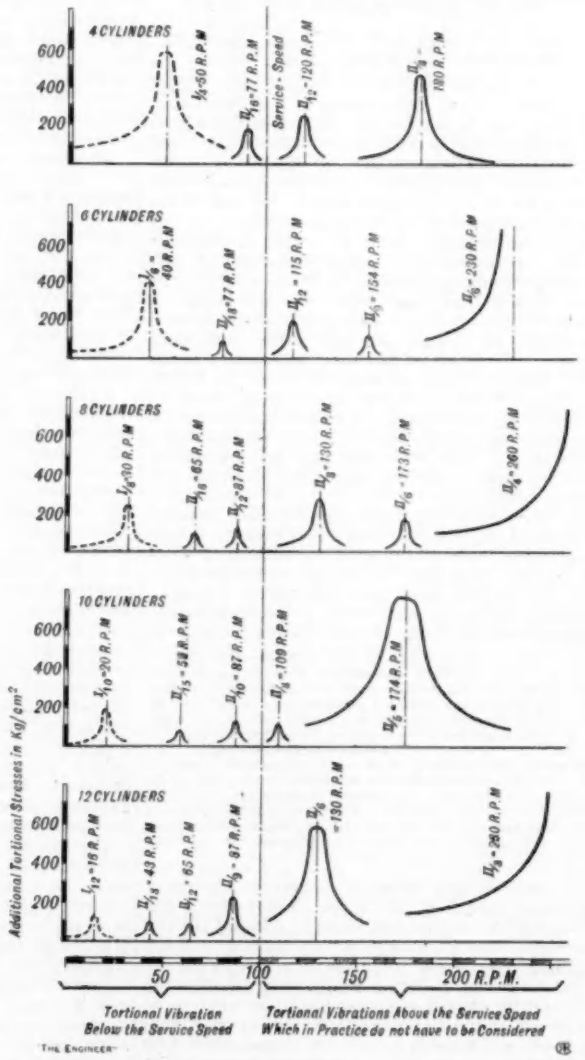


FIG. 3—CRITICAL SPEEDS AND ADDITIONAL TORSIONAL STRESSES

* Institution of Naval Architects, April 11th.—Abridged.

In multiple-cylinder engines some harmonic forces of the same order from the different cylinders become superposed, others cancel out or their resultants become so small that they can be neglected for practical purposes. In a four-cylinder engine, for instance, the 4th and 8th order become important. The actual maximum stresses in the shafting, which theoretically become infinite, are limited by the damping effect, principally due to friction. In this paper the engine speed at which, for example, the 4th harmonic force coincides with the form of vibration with one node is termed a critical speed of the first degree, 4th order. Vibration with two nodes, caused by the 12th harmonic, is termed a vibration of the second degree, 12th order. In the example shown in Fig. 1, the natural period of vibration of the first degree is 386 per minute and that of the second degree is 1406 per minute. The natural periods for three, four and more nodes lie so high that they practically no longer come into consideration, since the harmonic forces decrease rapidly for the higher orders, and their magnitudes are practically insignificant from the 12th order upwards. In marine engine installations the conditions are generally such that the critical speeds of the first degree make themselves noticeable principally in the intermediate shafting behind the flywheels, those of the second degree principally in the crank shaft.

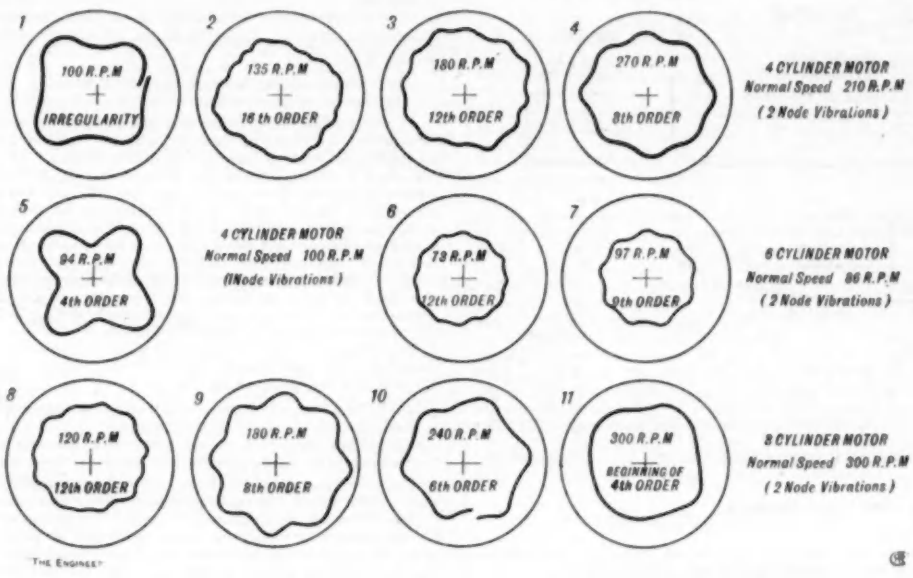


FIG. 4—CHARACTERISTIC TORSIONAL DIAGRAMS OF MARINE DIESEL ENGINES

The theoretical principles used as a basis for calculating torsional vibration have been known for some time, and the first attempts to determine experimentally this type of vibration, the amplitude of the deflections and the magnitude of the additional torsional stresses in marine steam engines, date back to the days when the Diesel engine had not yet been adopted as a marine engine. In Diesel engine construction the first difficulties made themselves manifest when six-cylinder engines with heavy fly-wheels and generators were introduced; then the significance of torsional vibration and the necessity of thoroughly investigating it became clearly recognised.

Various methods—mechanical, optical and electric—may be and have been adopted for measuring torsional vibrations. The handiest instrument, and, therefore, the most widely used, is the torsiograph. Some characteristic torsional diagrams are given in Fig. 4.

In the case of engines with four or six cylinders, such as are sometimes installed in tankers and fitted aft, the most important critical speed is of the first degree; this will have an unfavourable influence, principally on the intermediate shafting behind the fly-wheel, and falls, in general, somewhere in the neighbourhood of the normal number of revolutions. By correspondingly increasing the diameter of the intermediate shafting, and possibly also by reducing the moment of inertia of the propeller and fly-wheel, it will generally be found possible to remove the critical speed to a safe distance above the normal service speed, as is explained in the example below.

In long intermediate shafting the critical speed, 1st degree, 4th order, lies, in the case of four-cylinder engines, so low that it is impossible to consider means of removing it above the range of normal service speeds. In such cases the shaft is built in accordance with the Classification Society's rules. The fly-wheel is chosen as heavy as possible in order to bring the critical speed down as far as possible into a region where the load on the engine is low. A heavy fly-wheel also reduces the additional torsional stresses in the shafting; the greater the fly-wheel effect of the engine, and the lower the fly-wheel effect of the propeller, the less the action of the stresses is felt. Of the critical speeds of the 2nd degree, the important ones of the 4th and 8th order lie far above the maximum service speed. The effects of the 12th and 16th orders are weak and insignificant; the additional torsional stresses caused by them scarcely reach 100 kg./cm.², and the region in which vibration can make itself perceptible extends over fewer than $\pm$ 2 revolutions. In order to ensure the best possible service conditions, and also to avoid these small additional stresses, an endeavour is made to keep the normal service speed at sea away from any of these subordinate critical speeds.

Of greatest interest are the conditions for six, eight, ten and possibly twelve-cylinder engines, which come into consideration mostly for passenger vessels. Fig. 3 shows the approximate position of the critical speeds and also the approximate amount of the additional torsional stresses to be expected.

Just as important as the torsional vibration of the shafting is the vibration of the ship. The ship as a beam with a certain elasticity and a known, although variable, distribution of the masses, can vibrate with quite definite natural frequency with two, three or more nodes. Vibration of the hull may originate in various ways, amongst others from free forces and moments from any part of the machinery. Here also the law holds that the amplitudes will increase with increase in the imposed forces and the more closely the impulses synchronise with the natural frequency of the ship. The maximum amplitude of the deflections is determined by the magnitude of the damping forces. If the impulse figure exceeds the period of natural vibration, the vibrations diminish rapidly in magnitude and importance. Also, small forces may make themselves unpleasantly felt when their frequency coincides with the natural period of vibration of the ship. On the other hand, large forces have no appreciable effect, if there is no synchronism. The following examples will explain this.

A yacht propelled by two four-cylinder, two-cycle engines, each developing 800 B.H.P. at 150 r.p.m., was absolutely free from vibration when proceeding at full speed. In harbour, however, when a small single-cylinder auxiliary compressor was in service, running at a high speed, the glasses in the saloon jingled. The fact that the effects of the free forces from this single-cylinder compressor were greater than those of the main engines was not the important point. The difference in their effects on the ship was due to the fact that in the case of the main engines neither the 150 impulses of the free moments of the 1st order nor the 300 impulses of the free forces and moments of the 2nd order coincided with the natural period of vibration of the ship, but that the much higher impulse figure

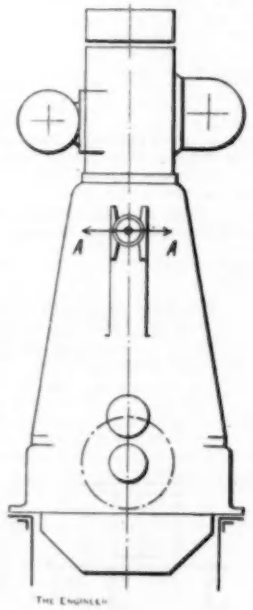


FIG. 5

of the free forces of the 1st order from the compressor did so. A second case concerns a ship equipped with two 4000 B.H.P., two-cycle engines and four-cycle auxiliary engines. The excellently balanced main engines did not cause the slightest vibration, whilst the high-speed auxiliary four-cycle engines with a great free force of the 1st order due to the unbalanced injection-air compressors caused such continuous vibration in the ship that their speed had to be very considerably reduced. In order to eliminate free forces of the 1st order entirely in slow-speed, two-cycle auxiliary engines, the cranks of the air pump and of the compressor are set at 180 deg. to each other. The same is done in main engines with direct-driven scavenging-air pumps. For the same reason, in high-powered marine engines with turbo-blowers, the compressor is subdivided into two equal cylinders driven by cranks set at 180 deg. to each other. The third case refers to a passenger liner with two large two-cycle engines. On one voyage the running gear of one cylinder—connecting-rod, crosshead and piston—had to be put out of action. This gave a free force of 20 tons of the 1st order, but in spite of that, no vibration could be felt in the hull of the ship, which can be explained from the fact that the normal speed of the engine was far removed from the natural period of vibration of the ship.

In order to avoid vibration in a ship, the possible natural periods of vibration of the ship should be calculated, and the speeds of the main and auxiliary engines chosen in such a way that no impulse figures of the 1st or 2nd order coincide with the figures found for the ship. It is also necessary to try to keep the free forces and moments as small as possible, so that, even if synchronism should occur, the deflections will be small and the range of speed over which they are noticeable is as short as possible.

The theory of balancing, and also the methods adopted to apply it practically, are well known. Less generally known is the fact that the absence of free forces and moments is no guarantee that the engine will be free from vibration. The whole theory of balancing holds in principle only for a rigid engine. In general, the free moments are eliminated by setting the cranks at such angles to each other that the considerable free moments in each half of the engine balance each other. This will cause a bending moment in the engine itself, which may give rise to a dangerous critical bending vibration in the engine if the frame is not sufficiently rigid.

Let us now consider a phenomenon which, in certain ships fitted with double-acting eight-cylinder, four-cycle engines, has led to severe shaking of the engines, foundations, and hull. This is a critical bending vibration thwartships, in the direction of the arrows A–A_1 in Fig. 5. The engine may be regarded as a beam fixed at one end in the foundations and vibrating in the direction A–A_1 with absolutely definite frequency. This vibration may become critical and the deflections attain dangerous amplitudes if the period of the impulses on the crosshead guides should coincide with the natural frequency. In single-acting Diesel engines with rigid frame construction and comparatively low centre of gravity, the natural frequency is so high that no trouble is to be expected within the normal speed range.

Whilst it is quite possible in advance to avoid any vibration in the main and auxiliary engines as well as in the ship as a whole, local vibrations may possibly show themselves in some parts of the ship. Such local vibrations can generally be easily removed by very simple means, such as by fitting a light stiffening, in order to change effectively the natural frequency of the parts in question.

In twin-screw vessels, vibrations have been observed which appear and disappear periodically, causing more annoyance than a continuous vibration. Such vibrations may be set up when the two main engines are not running at exactly the same speed, so that at a certain moment the free forces are superposed, thus doubling the intensity of vibration, and at the next moment they cancel each other and the vibration disappears. In quadruple-screw ships it is practically impossible for the free forces or moments from all four engines to become superposed in such a manner; in addition to that, distributing the output over four engines means that the working parts are lighter, and the effects of the moving masses are consequently smaller, so that such vessels are particularly free from vibration.

Besides the causes already named, there are others which may cause vibration on board ship. From what has been said it is clear that these come into consideration not only for motor ships, but also for ships propelled by reciprocating steam engines and to some extent also for steam-turbine-driven vessels.

The avoidance of all critical speeds in the main and auxiliary engines—the absence of bending vibration and critical transverse vibration—the excellent balancing—and the great distance between the service speed and the nearest period of natural frequency of the ship—all these facts have contributed to establishing conditions for normal service which could not be bettered on a passenger ship.

The Behaviour of Two Passenger Vessels.*

By Dr. B. C. LAWS.

THE salient features of this paper bear upon the results of observations made on certain vessels under sea-going conditions during a voyage to Australia and back. The voyage commenced in the summer of 1928, from London, *viâ* Suez and Colombo, to Melbourne, and the return from Australia was made on a second vessel belonging to the same company. On one of the vessels creaking at certain parts of the structure had been experienced, more noticeably when conditions beyond the normal were encountered. While there was nothing disconcerting in this occurrence, it was thought that it might afford a useful study.

The voyage was undertaken at the direction of the Committee of Lloyd's Register of Shipping by arrangement with the owners, with the object of ascertaining:—

(1) The cause of the creaking referred to, and the means by which, if possible, it might be eliminated;

(2) The evaluation and, where possible, co-ordination of certain primary features of design and construction which might be of material assistance to the shipping company and to the shipping community generally and of value to the Register.

Considering the time of the year, it was not anticipated that very severe weather would be encountered, but it was expected that on a voyage extending over some three or four months rough weather would be experienced at intervals.

Strong winds and moderately heavy seas were met with in the Arabian Sea, from Colombo to Fremantle, and in the Australian Bight, sufficiently severe to enable one to draw certain conclusions as to the effect of the weather on the ship's structure. For the purpose of the work in hand the following arrangements were made, viz.:—

(1) Angular movements of the vessel were observed

* Institution of Naval Architects, April 10th, 1930.—Abstract.

from a pitch indicator—kindly lent by Mr. G. S. Baker, Superintendent of the William Froude Tank, the National Physical Laboratory, Teddington—set up in the chart room, and by means of a pendulum suitably suspended to indicate rolling, so that the transverse and fore-and-aft angular movements could be noted simultaneously.

(2) Particulars relating to weather were abstracted daily from the ship's log throughout the voyage.

(3) No mechanical means were adopted in observing waves, but their length and height were estimated from time to time by observing progressive series of waves

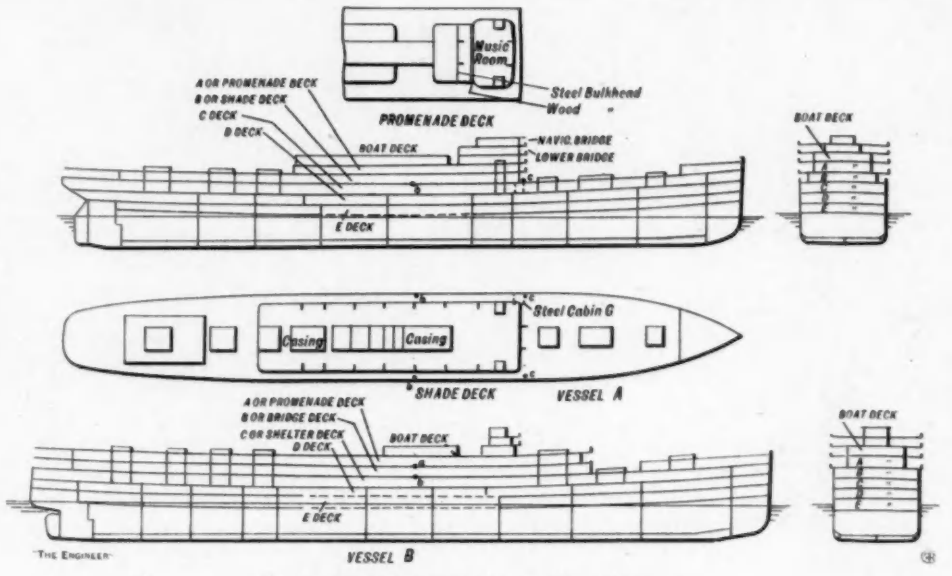


FIG. 1—ARRANGEMENT OF THE TWO VESSELS

and utilising one's knowledge of distance and height, supplemented by the opinions of responsible officers on board. The direction of the waves was obtained by the aid of a specially made protractor mounted with a long pointer, which could be brought into parallel with the wave front. Observations were made generally, according to convenience, from the bridge and forecastle head.

(4) Racking—principally relating to the superstructure—was measured by means of pianoforte wires in direct association with springs of known elasticity, and tightening screws, attached at one end to a suitable point in the erection, and at the other to a relatively fixed point in the main structure.

(5) Straining of the structure was determined by means of a specially designed strain meter, capable of taking continuous and autographic records at any desired position in the vessel.

As far as possible the arrangements referred to were brought into operation jointly under favourable weather conditions.

The vessels—designated A and B respectively—both of transverse construction, are illustrated in Fig. 1 and may be described as follows, viz.:—

Vessel A.—Principal dimensions, 550ft. by 72ft. by 51ft. to shade deck. The shade deck of this vessel forms the top member of the girder. The erection on the shade deck covers 220ft. amidships with an open alleyway on each side. The promenade deck above extends from the front of the erection right aft. The superstructure rises perpendicularly at the front of the erection to a compass platform at a height of 40ft. above the shade deck. There are no expansion joints. The machinery is turbine.

Vessel B.—Principal dimensions, 600ft. by 73ft. by 53ft. to bridge deck. In this case the construction generally is similar to that of A, except that the erection above the weather deck forms a constituent part of the structure, is carried further forward, and completely closed with a bulkhead at the front. The superstructure on the promenade deck extends to within 8ft. of this bulkhead, and the erections above the boat deck are set back another 52ft. There are three expansion joints, one on the promenade deck aft and two on the boat deck, one at amidships and the other immediately over that in the promenade deck aft. This vessel has reciprocating machinery. No signs of undue stress were observed in B, and no measurements for racking were made.

In the case of vessel A there were indications of racking in the superstructure depending on the weather conditions, and any movements were carefully observed. On this account it is necessary to give some details of the general design of the superstructure. This latter is shown in Fig. 2.

The creaking referred to was more noticeable when the vessel was pitching and the wind abeam, but less when pitching only was experienced. At certain parts of the vessel overstraining was exhibited. There was also vibration, though not objectionable, due to synchronism between the hull period and revolutions of the propeller when the latter fell below a certain value.

It will be noticed that the windows—rectangular—in the lower erection are situated between consecutive plate edges, the space below the window being filled in by a separate piece of plate containing a V corrugation as indicated in Fig. 2, and the space above the window is filled in with wood panelling. The attachment of the plating at the top to the promenade deck is intercostal between the beams, and obviously is less efficient than the continuous attachment at the bottom to the shade deck.

The riveting at the butts or edges of the plating, especially in way of the foremost windows, showed signs of straining. At the apex of the V corrugation under the two foremost windows the plating fractured, and movement at this part was quite perceptible to the touch. There was evidence of springing at the corners of the erection on the shade deck, and the foundation bar riveting at this position showed signs of working.

Wind.—At intervals during the voyage considerable wind force was experienced, the effect of which on the superstructure will be examined.

Particulars of the worst weather (wind) conditions experienced are set out below :—

Position of ship.	Weather.	Beaufort's numbers.	Average velocity of wind.	Maximum velocity of wind.
			Miles per hour.	Miles per hour.
Colombo	Moderate—fresh gale	5–6	22	33
	Fresh gale	7–8	34	47
Fremantle	Fresh gale—storm	8–10	44	73
Between Adelaide and Melbourne	Fresh gale	7–8	34	47

Measurements of straining, &c., were made at those times when the motion of the vessel was conducive to reasonable and measurable results, and may be grouped under the following heads, viz.:—

(1) Racking of the erections or superstructure ;
(2) Straining of the material at certain parts of the vessel ;
(3) Pitching ;
(4) Rolling.

(1) *Racking.*—It was not considered necessary to take any account of racking in the case of vessel B. Racking was apparent in vessel A, being most pronounced at the fore part of the erection above the shade deck and in way of the music saloon on the promenade deck, and may be attributed to two primary causes :—

(*a*) To the superstructure being more or less detached from, or, at least, forming no constituent part of the main structure of the vessel.

(*b*) To the superstructure rising to a height of some 40ft. without break or step, exposing a large area to concentrated wind force, and inducing in itself considerable momentum when the vessel was pitching and rolling.

The method generally adopted is illustrated in Fig. 2 and consists in stretching a pianoforte wire through a spring between two points, one in the erection side or front and deck respectively in the several 'tween decks.

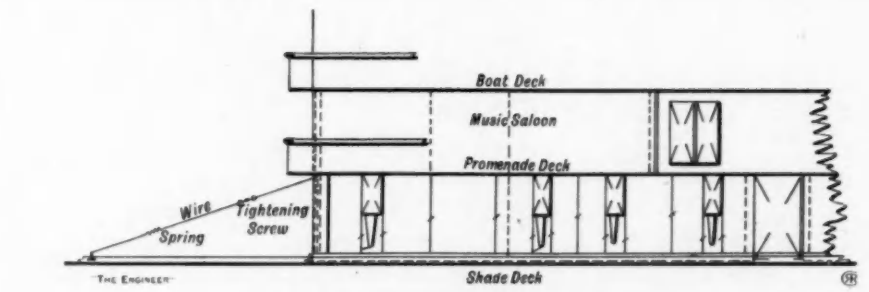


FIG. 2—SUPERSTRUCTURE OF VESSEL A

The relative separation of the two points is measured by means of two pointers mounted excentrically on the spring. Two corresponding ends of the pointers being kept at a fixed distance apart, the magnified movement along the wire may be read at the other ends of the pointers by means of a finely divided scale and magnifier.

After making the necessary corrections the net movements (of superstructure) at the several positions relative to the shade (strength) deck were estimated.

The movement was not great, but sufficient to produce appreciable straining in the materials and attachments. The amount is a fluctuating quantity, dependent in any particular case upon whether :—

(1) The superstructure or any portion of it forms a constituent part of the structure proper ;
(2) The vessel at the time is subject to hogging or sagging ;
(3) The pitching is clockwise or anti-clockwise ;

the limiting or maximum effect resulted from the following conditions :—

(*a*) Vessel hogging with pitching clockwise ;
(*b*) Vessel sagging with pitching anti-clockwise.

At any vertical section, say, from the shade deck to the navigation platform, movement will be resisted at the various deck levels or hard points of the section. At these positions it is likely to be less than if the superstructure varied gradually from top to bottom. If the shade to promenade 'tween deck can be considered as partaking of the main structural straining, while the superstructure above the promenade deck does not, but moves more or less freely, the movement will be different from, and may be even greater than, if the structure proper stopped at the shade or strength deck. Whatever part of the lower superstructure plays, it need be sufficiently strong at least to support efficiently the weight above.

In estimating the net movement in the present case, therefore, the condition is obviously somewhere between those under the assumption :—

(*c*) That the whole of the superstructure above the shade deck is more or less free to move ;
(*d*) That that part of the superstructure above the promenade deck has more or less freedom of movement.

The remaining factors to be considered are "wind force" and "momentum" in consequence of rolling and pitching.

The effect of wind pressure in producing movement of the superstructure may be taken generally as relatively small, though not altogether to be ignored, depending upon the prevailing weather conditions. For the actual conditions experienced it is estimated that the steady normal wind pressure would be about 2·5 lb. per square foot, corresponding to a wind speed of $\sqrt{\frac{2 \cdot 5}{0 \cdot 003}} = 29$ miles per hour, and in gusts to $29 \times 1 \cdot 3 + 1 \cdot 5 = 39$ miles per hour, equivalent to a pressure of $0 \cdot 003 \times 39^2 = 4 \cdot 5$ lb. per square foot, giving a force not greater than 3¼ tons, equivalent to 40 foot-tons moment about the shade deck. The corresponding moment on account of momentum due to pitching would be about 240 foot-tons, so that whereas in a hurricane the full effect of wind might approach or perhaps exceed that due to pitching, in the present case the moment due to wind is only one-sixth of this amount ; that is, the primary factor in causing movement or deflection of the superstructure is momentum due to pitching.

Evidence of shear indicated was seen in the movement manifested in the riveting of the attachment angles to the shade and promenade decks. Although this was most in evidence at the fore end of the erection, tendency to shear was also exhibited at the after end, and more or less generally in the attachment angles to the promenade deck and in the vertical edge or butt riveting of the erection side plating. It would seem that in this case economy in material was aimed at, and an attempt made to relieve the reduced material of stress by introducing the corrugations at and below windows in the shade promenade 'tween deck. The effect does not appear to have been attended with success.

In the neighbourhood of the corners of the erection front indication of springing was exhibited by the apparent working of the rivets in the foundation bar, and discoloration in way of the riveting seen in the cabins below the shade deck. The vertical stress at this point—due to movement of the superstructure—namely, 1·83 tons per square inch, represented an axial pull of 2·3 tons or 3·8 tons per square inch on the rivets, while the shear on the rivets resulting from horizontal stress of 3·24 tons per square inch in the material at the deck level due to structural straining is equal to about 6·9 tons per square inch, or a principal stress of 7·1 tons per square inch in the rivet material. At this position some creaking was experienced in way of the cabins on the port side in the 'tween deck below. The cause of the trouble was traced to a cabin—G, Fig. 1—originally intended for a bathroom and lightly built of steel, situated immediately below the erection corner. On removing a portion of the lining the plating was found to be fractured at the upper corners of the doorway, and the attachment of the plating to the deck started. Obviously the steel work of the cabin was not sufficiently strong to take the pulsations transmitted to it from the deck above—a point which is worth consideration in any proposal to introduce a piece of light construction in a neighbourhood where severe straining is likely to be transmitted. The creaking referred to resulted from the grating on each other of the fractured portions of the plating.

It was not found convenient to take measurements of transverse movements in the shade promenade 'tween deck. Relative movement of the promenade to boat decks

transaversely was measured, however, in way of the music saloon.

A general examination of the data and design points to the necessity of making adequate provision against the effects of :—

(1) Concentrated load ;
(2) Wind force and angular acceleration in consequence of pitching and rolling ;
(3) The transmission of structural stresses to the superstructure.

Secondary causes of the creaking referred to may, perhaps, be ascribed to the wide spacing of the pillars in way of the music room and under the forward end of the erection, and to want of continuity of pillaring at this part from deck to deck, and to friction between bearing surfaces of wood against wood or steel. With regard to this latter, and with a view to diminishing friction, it is thought blacklead or thin felt might be usefully employed between the bearing surfaces of wood in the construction of cabins and public rooms of passenger vessels, much in the same way as is done in the case of yacht work. There is, naturally, difficulty in introducing additional strengthening —especially in a passenger ship—after the vessel is built and has been on service. In the case under consideration, however, steps were subsequently taken to remedy the troubles which had been discussed, with, it is believed, satisfactory results.

South African Engineering Notes.

South Rhodesia's Minerals.

SOUTHERN Rhodesia's mineral production last year amounted to £4,871,774. This compares with £4,448,311 for 1928, and shows an increase on the year of £423,463. The gain was caused almost entirely by the larger output of asbestos and chrome ore. There has in the last year or two been an active development of asbestos, the output of which in 1929 was 42,633 tons, of a value of £1,186,627, or £216,300 more than in the previous year. Chrome ore was mined to the amount of 93,116 tons, having a value of £674,937, or £203,270 more than in 1928. Gold still represents nearly one-half of Rhodesia's total mineral production, but the country's production of it has in recent years shown a declining tendency. The output last year was £64,048 smaller at £2,374,359, having fallen from over £3,000,000 in 1922.

Earth Tremors on the Rand.

The earth tremors that shake Johannesburg occasionally become more frequent and violent as time passes. Experts, however, do not fear any really serious subsidences in the old mine workings such as would be likely to endanger the architectural stability of the city. The earth tremors of the Rand, as distinct from the more widespread occurrences of local rock burst in mines far apart that are probably confined to the solid strata of stope faces, would seem to be concentrated along the immediate southern boundaries of Johannesburg itself. The locale comprises the mining area once popularly known as the "Golden Mile," which, roughly speaking, extends from the old Bonanza to the City and Suburban mines' western boundary. This area is honeycombed with extensive excavations made at a time when scientific mining practice was hardly known, and rich ore to the last cubic foot was relentlessly extracted. This particular danger is probably confined to the first thousand feet below the old outcrops, extended at odd points into the much deeper levels of newer mines, which faulty mining methods have also made subject to severe tremors caused by the sudden caving and subsidence of the upper workings. Subsidences in the old outcrop mines which largely account for earth tremors, are probably due to the extensive excavation of the many separate reef bodies that lay one on top of the other at short range. Thus, the honeycombed state of the abandoned old mine workings as distinct from the condition in the deeper mines, where, at most, two reefs are being worked, may be regarded as the cause of the tremors. Presuming this explanation to be the correct one, the earth tremors should diminish in frequency once the older workings have gradually caved and subsided into contact with the solid footwall foundations.

Long Underground Level.

What is probably the longest level on the Witwatersrand, and most likely one of the longest levels in metalliferous mining anywhere in the world, will be completed in about four months' time. This is the seventh level in the Geduld Proprietary and the third level in the East Geduld, situated at an approximate depth of 2500ft. from the surface. This level will be no less than 28,000ft., or over 5 miles, long. It commences on the Geduld–Government Gold Mining Areas boundary, almost under the sand dump of the latter property. It then swings past Geduld's No. 7 shaft almost into Springs Mines, and then, on account of a change in the strike turns almost at right angles, and then under the railway line between Geduld and Welgedacht.

Tenders for Steel Works.

The tenders for the works of the South African Iron and Steel Corporation, Ltd.—the State-controlled enterprise—were to be opened on April 12th. Mr. C. F. Delfos, director of the Corporation, left for England in March to attend the opening of those tenders, which had been sent to London, and the Board in South Africa opened those which had been sent to Pretoria. The amount involved, it is stated, will not exceed the amount laid down in the Parliamentary estimates, which is £3,500,000, and it is likely, in view of the keen competition in England, America and the Continent, that the works will not cost nearly as much as this. A rumour has been in circulation that the Iron and Steel Corporation is £2,000,000 short of the total capital required, but this has been flatly contradicted by Mr. Delfos, who is exceedingly optimistic regarding the future of the undertaking which, he declared definitely, will be erected at Pretoria. For years strenuous efforts were made to interest British engineering and steel-making companies in the project, with no success whatever. Comparatively little trouble was experienced, however, when continental firms were approached. German works sent out some of their foremost experts who spent months investigating and supplied a most lengthy and elaborate report upon the project, in which every aspect of the problem was thoroughly dealt with. This report convinced the Government of the feasibility of the enterprise and is the basis upon which the size of works, &c., has been computed. When the tenders are considered, the help rendered by those German firms will undoubtedly be a big factor in deciding to whom the orders for plant, machinery, &c., are to go.

Rand's Working Costs.

Although the gold mines of the Witwatersrand reduced working expenditure by 2d. per ton milled last year as compared with 1928, the total disbursement on working expenditure were £221,000 more in 1929 than in the preceding twelve months. This is a fact that is not generally appreciated by the average member of the public, who hears that working costs have been reduced, but does not realise that, inasmuch as a greater tonnage was handled, the aggregate working expenditure—that is to say, the bill which the mines meet for wages, stores and supplies, &c.—was nearly £20,000 per month more. Publication by the Government of figures relating to gold production in the Transvaal and on the Witwatersrand last year makes it appropriate to refer to some of the more outstanding of these statistics. The tons treated amounted to 30,741,854, or, roughly, 100,000 tons for each working day throughout the year. This was an increase of over half a million tons on the previous year. The production at 9,979,106 oz. was 80,000 oz. more, and if adequate supplies of native labour can be obtained it seems not improbable that this year the output of the mines will rise to over 10 million ounces for the first time in their history. Last year the Witwatersrand gold mines disbursed more than 8 million pounds sterling to Europeans directly engaged in the service of these mines. The exact figure was £8,013,231. Aggregate working costs last year were £29,819,536, or nearly 2½ million pounds sterling per month.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Easter Holidays.

THE week has been one of very limited activity in the Midlands and Staffordshire, and, apart from the blast-furnaces, most of the works have been idle during the major portion, if not the whole, of the week. Manufacturers' order books were so sparsely filled that in the majority of cases they were under no necessity to put plant into operation before Monday next. The exceptions were the works in the Black Country engaged on the production of high-class bars. For that material makers have a substantial tonnage of orders for execution, and it was found desirable to resume work with the afternoon shift on Tuesday. At the weekly meeting of the iron and steel trade in Birmingham to-day—Thursday—a holiday atmosphere was still in evidence. Comparatively little business was transacted, and interest centred in the meeting of the Central Pig Iron Producers' Association, as pig iron prices were understood to be under review. Though up to the time of writing the Association decision was unknown, there was an impression on the market that quotations would be reduced. There was no certainty, however, about the position. In other departments of the market values were steady, and orders were of small content. With the turn of Easter, better things are looked for by Midland industrialists, and a number profess to discern more favourably omens than have been apparent so far this year. Some comfort is derived from the rather better showing of iron and steel in the export and import returns for the month of March. To the increase of 38,000 tons odd in overseas deliveries of iron and steel last month, pig iron contributed nearly 13,000 tons. Shipments were 65 per cent. in advance of those made in February, though they were not quite up to the January figures. It may be recorded, however, that foundry iron exported was larger in bulk than in any previous month this year. March proved the best month in the quarter as far as exports of steel bars and sections, galvanised sheets, tin-plates and railway material were concerned. Further satisfaction is derived from the fact that the output of crude iron and steel in March was larger than the output in either January or February. While many Midland manufacturers and engineers are short of work at date, an improving tendency is reported in some directions, and a more hopeful tone exists. An expansion of demand in the near future is looked for.

Pig Iron Prices.

Business has been very unsettled in the pig iron department for some time, but matters should come to a head this week. Demand from the ironfoundries in the Birmingham district is so restricted as to suggest that users are definitely keeping stocks down to the smallest possible tonnage in the hope of cheaper pig iron. Prices are to be reviewed to-day at the monthly meeting of the Central Pig Iron Producers' Association, and merchants and consumers consider that some concession will then be declared. Furnacemen do not give any definite indication that they will yield to the pressure for cheaper iron. They say they are still using coke which costs them 18s. a ton or so, on old contracts, though it is true that bargains have been made within the last week around 14s. At the time of writing there was no certainty that prices would fall, despite the impression among consumers that they must. A good deal will depend probably on whether furnacemen think that the granting of concessions would give a new impulse to trade. Some of them are accumulating stocks rather more rapidly than they care for, and would be glad to see the opening of an outlet. It should not be forgotten, however, that most of the Derbyshire furnacemen are finding outlets for practically all they have to sell, as in their case supplies to the open market are moderated by the activity of pipe foundries operated in conjunction with the furnaces. Recently, too, the district output has been reduced somewhat, owing to temporary withdrawals of one or two furnaces for repairs. Whatever accumulation of stocks there is must be sought mainly in the North-amptonshire district. Moreover, furnacemen had such a bad time before they put their heads together last year that they are in no hurry to forego the initiative. As to the overruling conditions of supply and demand, producers believe that consumers have only been able to hold off the market by reducing stocks to the barest proportions, and that as the spring advances they will be forced to buy. Nevertheless, at the time of writing there is a fairly general expectation among consumers and merchants that the review of prices will result in the declaration to-day of a reduction in all grades of forge and foundry iron made in this district.

Raw Iron Production.

Production figures for last month are encouraging. Although five blast-furnaces went out of operation, the output of pig iron totalled 665,800 tons, as compared with 607,000 tons in February and 650,000 tons in January. When allowance is made for the short month, it will be seen that improvement has been progressive.

Finished Iron.

The bright spot of Staffordshire industry at date is the marked bar trade. Some firms have had a good run of business for some months past, and works have curtailed the Easter holiday, recommencing operations on Tuesday last. These makers of high-class bars had a substantial carry over of orders, while the inflow remains satisfactory. Marked bars are quoted £12 10s. at makers' works, and quite a brisk business is being done. Conditions in the medium and common bar branches are not so satisfactory, however. Here business is poor and difficult to negotiate, and the works have for some time been on short time. This has been rendered essential if the mills were to be kept from closing down. Quotations of Crown bars range from £10 to £10 7s. 6d., and ironmasters are pressing for a reduction in pig iron costs to enable them to reduce their prices and so compete with makers from other districts who are securing a good deal of business from this market. Staffordshire makers are hopeful of a change for the better in the near future. In the nut and bolt bar department makers are unable to compete against Belgian No. 3 iron used for a similar purpose as Staffordshire common bars. They maintain their selling figure at £9, because they cannot afford to go lower. Belgian No. 3 bars which are not in the list of continental controlled products are being pressed on the market. Continental works are anxiously seeking business, and they have this week offered No. 3 Belgian iron at £5 2s. 6d. f.o.b. Antwerp, or £6 5s. delivered locally. Makers of the specially tested material for the chain and cable trades are not very well off for orders, and a week's stoppage will create no working inconvenience.

Steel.

In the steel trade prices are unaltered. Heavy steel is only in moderate demand, as constructional engineers need orders. Consumers of plates are in none too enviable a position, and tonnages purchased are relatively small. Ship, bridge, and tank plates are £8 17s. 6d. per ton, subject to rebate, while boiler plates are quoted £9 12s. 6d. upwards. Staffordshire re-rollers are operating within a narrow market, their difficulty being inability to sell small bars or strip at prices which would put them on a competitive level with foreign exporters. For small steel bars £8 is quoted as a minimum, with some firms, rolling British material, asking up to £8 15s. per ton. Trade in billets is poor, makers effecting few sales, even at £6 2s. 6d. delivered. Staffordshire hoops command £10 at makers' works. It is noted here that the output of steel ingots and castings last month totalled 826,100 tons, as compared with 776,400 tons in February and 761,100 in January.

Sheets.

Current demand for galvanised sheets continues disappointing. Values are unchanged at £11 17s. 6d. f.o.b. for 24 gauge corrugateds. While home business has been a little better, export orders, which are the mainstay of the trade, are exceptionally slack. Some of the mills were able to resume about the middle of the week.

Scrap.

The steel scrap market is almost stagnant, but some merchants claim to observe signs of a new buying movement. This week the weakness of the position is very marked. As low as £2 13s. 6d. has been paid for delivery into local works, and the South Wales consumers who usually take large consignments from this district decline to pay more than £3 2s. 6d. delivered.

South Staffordshire Iron and Steel Institute.

At the annual meeting of the South Staffordshire Iron and Steel Institute at Dudley, Mr. T. Hoskinson, of the Earl of Dudley's Round Oak Works, was elected President for the ensuing year. Messrs. R. P. Bethell and A. E. Osborn were elected Vice-presidents ; and the Treasurer and Secretary, Messrs. Harold Piper and S. G. Astbury respectively, were reappointed. Mr. Astbury stated that there were 204 members, an increase of thirty-three compared with the previous year, and the income was slightly in excess of the expenditure. Success had attended the institution of the associated section for young men, the headquarters of which were at the Wednesbury Technical College. There were now about forty associate members, and the development was regarded as of great promise for the future.

£170,000 Contract for Darlaston.

The announcement that a Black Country engineering firm, the Wellman Smith Owen Engineering Cor-

poration, Ltd., of Darlaston, has just secured a large order for machinery from a North American firm, in the face of strong German and American competition, is particularly encouraging. The order, which represents a value of £170,000, includes machinery for making seamless tubes, cranes and electrical gear, and will not only keep occupied a good deal of plant at the factory concerned, but will bring some good business to other South Staffordshire firms.

Staffordshire Pit Closing.

After sixty years' working, the Burley Pit, Apedale, Staffordshire, is said to be "pretty well worked out," and is to be closed. Notices terminating their employment were handed on Saturday last to between 600 and 700 men employed at the pit.

LANCASHIRE.

(From our own Correspondents.)

Manchester.

Traders Oppose £1,000,000 Bridge Scheme.

The Trafford Park Traders' Association, which includes the majority of the big firms established in the Trafford Park industrial area of Manchester, has just issued a report in which strong opposition is raised to the proposed construction of a new high-level bridge, at an estimated cost of about £1,000,000, for the purpose of relieving traffic congestion over the swing-bridge crossing the Manchester Ship Canal at Barton. Opposition, however, is not merely of a negative character, for, as a counter-proposal, it is urged that the construction of a tunnel under the Ship Canal at Barton would not only provide a more efficient solution of the problem, but also a more economical one. It is stated that there is engineering authority for the belief that the suggested two-way tunnel under the canal could be constructed at a cost which would represent a saving of about 20 per cent. compared with the bridge scheme. One of the grounds for the opposition of the Traders' Association is that the proposed bridge would interfere with the work of the Trafford Park railways and the rights of the frontagers.

Keeping the Mersey Within Bounds.

The Lancashire County Council has been recommended by its Agricultural Committee to give support to a scheme designed to prevent erosion damage by the River Mersey in certain areas in Lancashire and Cheshire. The recommendation of the Agricultural Committée is conditional on the Cheshire County Council and certain local authorities according financial support to the scheme, which would cost something like £150,000, and also on a grant equivalent to three-quarters of the cost being forthcoming from the Government. The scheme will be considered by the Lancashire County Council next week.

Fleetwood's New Sea-wall.

Fleetwood's attempt to prevent a repetition of the disaster which overtook the town two and a half years ago culminated on Tuesday of this week in the ceremonial unveiling by Lord Derby of commemorative tablets on the new sea-defence wall which has just been completed after two years' work and the expenditure of about £60,000. The wall is 1940 yards long, from 13ft. to 17ft. wide, and its height and strength are calculated to resist a tide of 38ft., which is 8ft. higher than has previously been known round this part of the coast. Lord Derby also formally opened a new £80,000 road in Fleetwood. This is a straight stretch of about two miles and reduces the distance between that town and Blackpool by a mile.

Textile Machinists' Trying Time.

Further unmistakable evidence of the growing depression which afflicts the Lancashire textile machinery industry is afforded by the balance sheet of Howard and Bullough, Ltd., of Accrington, for the twelve months to the end of March. The net profit amounts only to £1610, compared with £71,447 in 1928–29 and £139,143 in 1927–28, and the distribution on the ordinary shares is reduced to 2½ per cent. against 8¾ and 10 per cent. respectively in the two preceding years, the sum of £55,000 having been withdrawn from the dividend reserves, reducing that fund to £295,000, the general reserve fund remaining at £250,000. The carry-forward is £3453, compared with £3093 in 1928–29 and £66,021 in 1927–28.

"Tramcars Must Go."

On the occasion of the opening of a new motor bus garage to accommodate between 60 and 70 venicles, the chairman of the Works Sub-committee of the Manchester Corporation Transport Committee—Councillor Meachin—said that it was realised that eventually the tramcars must go, but whilst the Committee intended to do everything possible to meet the increasing demand for buses it was obvious that even if it were practicable it would be uneconomical, in view of the fact that about £4,500,000 was sunk in the Manchester tramway undertaking, to scrap the tramcars immediately. The change, he said, would have to be carried out gradually. The new garage covers an area of 1¼ acres in Princess-road and cost £32,500 to erect.

Steam Users' Association.

The following have been elected members of the Committee of Management of the Manchester Steam Users' Association for the ensuing year:—Mr. Harold Lee, Manchester, president, and Messrs. James Stanley Addison, London; J. T. Browne, Walkden; Charles W. Crossley, Halifax, and G. Leonard Bolden, Manchester.

Non-ferrous Metals.

Copper has attracted to itself pretty well all the attention of the non-ferrous metals market during the past week, for the decline in prices that has occurred in this section has been little short of sensational. A cut of £18 a ton in electrolytic metal by a stroke of the pen took the market by surprise, but it is obvious that the pressure exerted by the statistical position was too much for even the powerful American export combine to resist any longer. The loss on the week in the case of standard brands has been between £8 and £9 a ton, whilst to go back thirteen months, at the height of the "ramp," it is interesting to reflect that prices were almost exactly £40 a ton above those current at the time of writing. In spite of the intervention of the holidays the turnover in the metal has been on a good scale and consumers are likely to take full advantage of the low prices now ruling. Interest in tin has been quieter and with further additions to warehouse stocks in this country values have lost ground on balance to the extent of rather more than £2 a ton. Both spelter and lead have weakened, in each case by about 10s. a ton, and the demand from consumers has been by no means active.

Iron and Steel.

The movement on the iron and steel markets locally since last report has been on very narrow lines and a return to normal conditions is not expected until next week. Particularly is this the case in respect of pig iron, the uncertain price outlook being the ruling factor. At the time of writing Midland brands are quoted at 77s. per ton for delivery in the Manchester zone, with Scotch at about 95s. and West Coast hematite at 92s., both delivered here. Bar iron is quiet but unchanged at £10 15s. per ton for Lancashire Crown material and £9 15s. for seconds. The steel market this week has been quieter even than before Easter, although this is, of course, due to the holiday aftermath. New business in all sections has been very limited indeed, and complaints regarding poor delivery specifications are still general, particularly from the constructional engineering branch, most firms in which are finding replacement work coming along disappointingly. Meanwhile, steel prices are unchanged on the week at £8 10s. per ton for joists, £8 7s. 6d. for sections, £8 17s. 6d. for tank plates, £9 7s. 6d. for boiler plates, from £8 to £8 2s. 6d., according to quantity, for small re-rolled bars, and £9 7s. 6d. for 3in. bars.

Barrow-in-Furness.

Hematite.

There is a period of quietness in the home market which is probably only temporary. In a week or two there should be signs of better trade as, to a certain extent, confidence has been restored. Fortunately, the American and continental trade continues to be steady, and regular shipments, combined with local demands on account of steel production, are keeping down stocks, which, on the whole, are low. At some works they hardly exist. East Coast competition is keener and is being felt. The iron ore trade is steady. It does not move either one way or another as regards local demands, but outside business has fluctuated somewhat. Foreign ore is in steady demand and likely to be. The steel market does not show much brightness, but Workington manages to keep going on railway material. Barrow is stopped this week. Hoops are quieter owing to new high tariffs on this production entering America.

SHEFFIELD.

(From our own Correspondent.)

A Broken Week.

As the working days of the present week have been reduced in most cases to about half the normal number, there is not much fresh evidence as to the state of the local steel trade. So far as one can judge the position, however, it affords very little ground for cheerfulness. Last week was exceedingly quiet, and, while it is possible to find a few firms in the east end which are fairly well off for work, there are others which found it necessary to have a longer Easter stoppage than usual. The unsatisfactory nature of the general position is shown by the fact that the unemployment figures issued in the middle of last week revealed an increase of 2500 over those of a month ago, and 10,000 on those of a year ago. The total number is 33,532, of whom 24,067 are wholly unemployed. While Sheffield is suffering so much from slackness, its neighbour in the heavy steel trade—the North Lincolnshire district—is doing remarkably well, all its works being fully employed. In Sheffield the output of open-hearth steel has been in excess of demand for the last two months, and there is grave fear that, in the absence of a revival of buying, further furnaces may have to be set down soon. While there is a large amount of work in hand in heavy forgings, the general demand for steel is on a restricted scale, and the railway plants are not working at all well. Leeds, which is largely interested in the making of railway rolling stock, could also do with a great deal more work. One job which is on hand at Leeds at present is the making of eight tank locomotives for the Gold Coast Railways by the Hunslet Engine Company, Ltd.

Special Departments.

One section of the steel trade which has reason to be satisfied with the Budget is that which is interested in the automobile industry. Sheffield has built up a large connection with the motor manufacturers for the supply of forgings, pressings, and stamping for cars, and also of special steel for the wearing parts which are subjected to the most severe stresses. As I have several times pointed out, the uncertainty with regard to the McKenna Duties has prevented the motor industry from giving out orders on its normal scale, and the demands on the Sheffield works have declined accordingly. However, it is now known that those duties are not to be interfered with—for the present, at any rate—and thus there is a prospect of increased activity for the departments mentioned. A side of the special steel trade which continues to enjoy great activity is that which produces stainless steel and its kindred materials, heat resisting and non-corrodible steels. There is continued expansion in the uses of these products, and the demand keeps up very well. A large volume of trade is also being done in cold-rolled steel and strip, but this is not up to former levels.

Government Contracts.

The latest list of Government contracts shows that work has been placed with a number of Sheffield firms in the steel and other trades. On the armaments side, the War Office is taking bullet-proof plates from Vickers-Armstrongs, Ltd., and Hadfields, Ltd. The Admiralty has placed orders for carbon tool steel with Thos. Firth and Sons, Ltd., S. Osborn and Co., Ltd., and Sanderson Brothers and Newbould, Ltd.; and for high-speed tool steel with the same three firms and also with the English Steel Corporation, Ltd., Edgar Allen and Co., Ltd., Wm. Jessop and Sons, Ltd., and J. J. Saville and Co., Ltd. The Admiralty is also to receive gun-metal and phosphor bronze from A. G. Wild and Co., Ltd., and fire-hearth gear from W. Green and Co. (Ecclesfield), Ltd., Moorwoods, Ltd., and Allen and Sons, Ltd. The Crown Agents for the Colonies have ordered fish bolts and nuts from Ibbotson Brothers and Co., Ltd., and tubes from Howell and Co., Ltd.

Trade with Russia.

Sheffield would very much like a restoration of trade on a full scale with Russia, which in pre-war days was one of its best customers for saws, files, reaper sections, and other products. Of late years the amount of trade has varied greatly, but has never been up to the old standard. According to a report of an interview given in Moscow by Mr. Saul G. Bron, the Soviet Trade Commissioner, who is coming to London shortly, prospects are improving, and a good deal has already been done. Mr. Bron gave details of contracts totalling £5,000,000 with British firms. One of these orders is with Imperial Chemical Industries, with whom he signed a contract on the 11th inst., for the purchase of fertilisers, dyestuffs, metals, and other products to the value of over £3,000,000 over a period of two years on "substantial credits." He also stated that a contract with Metropolitan-Vickers involves £2,000,000 on long-term credits, and that the first British tractors have just been bought from Vickers-Armstrongs.

Blow to the Cutlery Trade.

The satisfaction with which the Budget statement has been received by the producers of motor materials and accessories is not shared by the people engaged in the cutlery trade. They read, with great disappointment, the Chancellor of the Exchequer's announcement that the Safeguarding Duty which they enjoy at present is to be allowed to lapse next December; and their feeling is all the stronger because, as I reported last week, they had presented a reasoned petition, showing how the duty had benefited the trade and asking for its renewal. Mr. Snowden's policy is regarded as a serious blow to the trade, and the possibility of some firms being forced out of existence is foreshadowed. It is well known that the cutlery trade of Solingen—sometimes described as "the German Sheffield"—has for some time been preparing to launch a campaign on the British market in anticipation of the expiry of the duty. Sheffield cutlers are expecting by this time next year the market will be flooded with pen and pocket knives, scissors, and safety razor blades produced in Germany under labour conditions with which we cannot and do not wish to compete.

A World's Coal Record.

We have in this neighbourhood a colliery which has set up what is declared to be a world's record in output for one week. This is the Silverwood Colliery of Dalton Main Collieries, Ltd., which, during the week ended April 16th, brought to the surface no less than 31,418 tons, from a depth of over 750 yards, as the result of 5½ days' ordinary drawing. Of this total, 25,001 tons were drawn from one shaft, which also constitutes a world's record. The other 6417 tons represent the output of the Roundwood Colliery shaft, which is used for the Roundwood Pit only. Silverwood's previous record was 30,924 tons for 5½ days' drawing, and 24,605 tons for one shaft. It is a tribute to Yorkshire mining enterprise that one colliery should be able to produce an average of about 5000 tons per day for a week at a stretch. Silverwood is ready for a coal boom, if one should come to test its powers. It could probably turn out a million and a-half tons per annum with ease.

Denby Blast-furnaces.

It is announced that Thos. W. Ward, Ltd., of Sheffield, who recently acquired the undertaking of the Denby Iron and Coal Company, Ltd., near Derby, have decided to dismantle the blast-furnaces, and that the work will begin at once. The colliery is to continue working, and will be developed, and the brickworks are to be restarted.

An Electric Cable Problem.

The Central Electricity Board is proposing to convey electricity from a transformer station at Grimsby to Lincoln, a distance of 30½ miles, by means of an overhead cable carried on 192 pylons. At Grimsby objection has been raised to the plan. At a Ministry of Transport inquiry last week opposition was offered by Alderman Frank Barrett, the owner of land which it is proposed to develop as a garden suburb, and on which the Board wishes to erect six pylons, carrying 4500ft. of cable. He stated that he was prepared to give facilities over other land, but the representative of the Electricity Board said that alternative routes which Mr. Barrett had suggested had not been found practicable. Objection was also offered by the Town Clerk, who, on behalf of the Corporation, urged upon the Board the wisdom of laying underground cables for that part of the line within the borough. He pointed out that Grimsby was a progressive town, and was about to spend £1,750,000 upon a new dock. The land required for the consequent expansion was proposed to be traversed by the line of pylons. The town already had one problem in its railway level crossings, and did not want to create another by permitting the pylons to be erected. Eventually it was announced that there was a prospect of the parties reaching an agreement, and the inquiry was adjourned.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Outlook.

THE outlook in the iron and steel trades in the North of England is very uncertain. Business is considerably below normal, and the immediate future is obscure, but as customers for most descriptions of material are understood not to have fully covered their early requirements, some expansion of market operations is looked for when the Easter holiday influences have departed. In certain branches contracts already made will keep plant employed for a while, but in one or two cases orders are rather urgently needed. Prices obtainable are unsatisfactory.

Cleveland Iron Trade.

The limited output of Cleveland pig iron is no more than sufficient to meet current requirements, and stocks at makers' works are likely to be reduced. Quantities of iron stored are not heavy and are stated to be largely sold. Merchants hold little Cleveland iron. Their opportunities to make home sales are slight, owing to conditions of contract with ironmasters, but they report a few inquiries from overseas. Actual export business is, however, very light. Producers continue to absorb much of the output at their own consuming works and have arranged one or two more contracts with home buyers, but are still unable to do much business with firms in Scotland owing to the keen continental and Indian competition. Makers adhere to their fixed prices, which stand at: No. 1 foundry, 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d., and No. 4 forge, 66s.

Hematite Pig Iron.

Conditions in the East Coast hematite trade are more unsatisfactory and discouraging than ever. There seems little or no early likelihood of a material expansion of demand, and continued excessive production is causing grave anxiety. Manufacturers are hampered by large and rapidly increasing stocks, and curtailment of output by the damping down or blowing out of furnaces in the near future appears to be unavoidable. Merchants have still quite a lot of iron and are keen sellers, while producers are prepared to give favourable consideration to offers below the unremunerative figures that are named. It is difficult to ascertain the lowest terms that might be accepted, but the equivalent of ordinary qualities at 74s. 6d. is a full quotation. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

Consumers of foreign ore are not interested in the market. They have larger stocks than they care to carry and hold long contracts. Best Rubio is put at 21s. 6d. c.i.f. Tees, but the quotation is purely nominal. Blast-furnace coke is abundant and difficult to dispose of. Good average qualities are easy at 18s. 6d. delivered to North-East Coast works.

Manufactured Iron and Steel.

There is no special feature in the manufactured iron and steel trade. Distribution of specifications for shipbuilding requisites are on a fairly good scale, and there is an increased demand for constructional steel. In other sections, however, more work would be welcome. Prices are firmly maintained.

The Coal Trade.

There are few encouraging signs in the Northern coal trade. A great change has come over the situation since the beginning of the year. The demand has declined and so have prices, and now some pits are losing more time than they have done for years. When orders fell off a while ago, the Northumberland collieries endeavoured to check the downward course of values by fixing minimum prices. These values have now little relation to the prices at which coal is being sold through contractors, and doubtlessly they will come up for revision before the month is out. Durham has no minimum prices and endeavours to maintain quotations by simply laying pits idle when there are no orders. The inquiry from abroad is backward and actual transactions just now are mostly confined to the negotiation of odd cargoes for early shipment, and these coals may be obtained easily and cheaply through second-hand sellers. The market for Northumberland steam coal is in the hands of the merchants, but, generally, nominal quotations range from 13s. 9d. to 14s. Tyne primes are weak at 13s. 6d. and seconds are about 13s. Small steam supplies are ample, Northumberland qualities ranging from 10s. to 11s. A similar state of affairs rules for Durham coals, and this market shows little chance of an early recovery. Prices for Durham steams are unchanged at 15s. 6d. to 16s. 6d. for large, and 13s. to 13s. 6d. for smalls. Other Durham qualities are also stationary in price, coking coal being at 13s. to 13s. 6d., secondary gas coal and ordinary bunkers at 13s. 3d. to 13s. 9d., best gas coal at 16s. to 16s. 3d., and best bunkers at 14s. 6d. to 15s. It is not easy to accommodate all the orders on offer for gas coke, and this is practically the only fuel on the market for which sellers can command steady prices. Patent foundry coke is 18s. to 20s.; beehive foundry coke, 26s., and special beehive foundry coke, 30s.

SCOTLAND.

(From our own Correspondent.)

Outlook Unchanged.

SIGNS of improvement in the steel, iron and coal markets are still lacking and it is difficult to find encouragement in any branch of industry. If anything, conditions have been quieter of late partly owing to holiday influences.

Steel.

The demand for steel, more especially of the heavy variety, continues on comparatively quiet lines, and there seems no reason to anticipate an early revival of interest in view of the probable slowing down of activities at the shipbuilding yards. Meanwhile specifications for plates and sections are most disappointing. Steel sheets are rather irregular. Ordinary black sheets are in moderate demand for shipment abroad, but galvanised descriptions are not receiving much attention. Sheet makers have still to meet competition from the thinner sizes of plates, which steel makers are producing owing to the scarcity of orders for heavy material. The position in the tube industry has not improved. Though producers are, of course, allotted their full quota of business by international agreement, the situation has been aggravated by the unfavourable state of affairs in Australia arising from fiscal changes and financial stringency.

Iron.

The difficulty in maintaining employment in the bar iron industry has not lessened. Specifications are extremely slow. The home price is fixed, but it is probable that the export quotation of £9 15s. per ton could be shaded for a good order. Re-rolled steel bars are similarly placed, and the quotation of £7 12s. 6d. per ton, home or export, is not tested.

Pig Iron.

Pig iron is more or less without fresh feature, and a small but fairly steady turnover is being done at the minimum prices fixed by agreement some months ago. Pig iron is still coming to this district, some 550 tons having been unloaded at Bowling last week.

Scrap.

Any movement in scrap is on modest lines. Consumers buy sparingly and prices as a rule are still comparatively easy, current quotations being in the region of 65s. for heavy steel, 62s. 6d. for heavy basic, and 69s. 3d. per ton for cast iron machinery scrap.

Coal.

The course of business in the Scottish coal trade continues unsatisfactory. The depression which became manifest some weeks ago has not lessened and the position becomes more acute as time goes on. The lack of fresh export orders is shared by the collieries in general, but is most keenly felt in the Lothians and Fifeshire. Importers abroad appear to be heavily stocked and are not in any hurry to take up contracts. Some, in fact, endeavour to obtain complete release from their obligations. Collieries, therefore, find it almost impossible to dispose of contracted fuel and sidings are becoming congested with unsold material. Prompt shipping business is meagre in the extreme, and forward transactions are well nigh impossible at present. Fifeshire first steams and treble nuts have shown a slight improvement during the past few days, but practically all other descriptions are in need of fresh business.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

OWING to the holidays there has been no movement of note in the coal trade, so far as either the anthracite or steam coal sections are concerned, while business has been practically at a standstill. The position in any circumstances is far from satisfactory, as a glance at the tonnage available shows. At the end of last week there were as many as forty-four idle tipping appliances at the various docks, and arrivals of steamers over the holidays have not been on a scale sufficient to enable the collieries to be busy this week. Shipments last week were very disappointing. There was no holiday rush for coals such as used to be experienced in years gone by, and there is no prospect of there being any loading pressure during the next week or so. The reason is that there is not the demand for coals, and furthermore the amount of chartering of late has been well below the average. Last week tonnage taken up was only just over 164,000 tons, which was 82,000 tons less than the preceding week. Notwithstanding the fact that records show that over 750 steamers of rather more than 4¼ million tons deadweight are laid up, there is more than sufficient tonnage being offered for employment on the market, which emphasises the meagreness of the demand for carrying space. In the absence of anything like active market conditions, it takes very little to create more than ordinary interest in any business that is available. It is reported that the Norte Railways have bought 15,000 tons of steam large coals at prices which are regarded as very low. Tenders were opened at Cairo on Wednesday for the contract for 250,000 metric tons of locomotive coals for the Egyptian State Railways. The lowest tenders for Welsh coals were:—Maris Export and Trading Company, Ltd., who offered 90,000 tons at 26s. 5½d. c.i.f. and 40,000 tons at 26s. c.i.f.; Tabb and Burletson, Ltd., 90,000 tons at 26s. 7½d.; Furness, Withy and Co., 250,000 tons at 27s. 4d.; Evans and Reid, 25,000 tons at 27s. 2½d.; T. Beynon and Co., 160,000 tons at 27s. 3½d. and 90,000 tons at 27s. 7½d.; Milburn and Co., 90,000 tons at 27s. 5d. The last contract was taken in December at 28s. 4½d. c.i.f. Alexandria.

Docks Working Hours.

Some surprise has been occasioned in coal trade circles in this district by the coal trimmers and tippers, who have called for a joint meeting of employers and representatives of the men to consider a proposal for the abolition of night work at South Wales ports. No doubt their action has been induced by the fact that coal-loading operations have of late been on a restricted scale. Their idea is to revert to the system under which two continuous shifts during the day were operated. It is very much questioned whether the employing interests will entertain the proposal put forward.

Coalfield Items.

The depression in trade is responsible for quite a number of miners in the steam coal area receiving notices to terminate their contracts. At the end of last week miners engaged at Hills-Llewellyn and Llewellyn Cyfarthfa pits, numbering about 2500, were given fourteen days' notices. Over 800 men at No. 8 pit, Tylerstown, belonging to Messrs. D. Davis and Sons, also received notices, while others similarly affected are 1500 men employed at the Cambrian Colliery, Clydach Vale, and 2500 men at the Glamorgan Colliery, Llwynypia. There has also been trouble at the Bargoed Steam Coal Colliery, belonging to the Powell Duffryn Steam Coal Company. Since Thursday in last week about 1000 men have been idle on account of a dispute concerning eight men engaged on a conveyor face. Hopes are entertained, however, that as a result of a meeting between the representatives of the employers and the workmen this week the trouble will be settled.

North Wales Coal Audit.

For the three months ended February the independent audit of the North Wales coal industry shows a credit balance of £37,300, equal to 9·88d. per ton on an output of 906,702 tons. In December the profit was ·92d. per ton, in January 1s. 1·51d., and in February 1s. 2·19d. per ton. Prices improved during this period from 12s. 11·39d. to 13s. 1·20d. per ton, while wage costs were reduced from 9s. 1·70d. to 8s. 8·02d., and costs other than wages from 3s. 8·77d. to 3s. 2·99d. per ton. The economic wage certified was 11·82 per cent. above the basis rate, but the minimum wage is fixed at 22 per cent. above the basis rates, and the deficiency through the payment of the minimum percentage amounted to £38,858, thus increasing the deficiency carried forward to £3,077,511. The output per man-shift worked over the three months was 18·61 cwt., and the average wages per man-shift 8s. 2·46d.

Moving Mountain.

Reference was made last week to the damage done to colliery property of the Powell Duffryn Company at New Tredegar by a landslide. Since then reports show that the movement of the mountain continues, though there are indications that it is coming to a stop. Falls of rock and earth take place intermittently, but not on the scale of a week ago. The main road between New Tredegar and Abertysswg has been swept away for a considerable distance, and the railway is buried still beneath thousands of tons of *débris*. As a result of the damage, the probability is that the New Tredegar Colliery will never be worked as it used to be. About 1000 men were formerly employed there. The Powell Duffryn Company has dismantled the screens and taken away very valuable machinery and other material. The working of the McLaren Colliery, Abertysswg, which employs 1000 men, has not been interfered with, as was at first thought would be the case.

Current Business.

The Coal and Shipping Exchange was closed this week until Wednesday, and consequently there has been practically no business passing. The tone of all sections is extremely quiet. Large and small coals are freely available for prompt shipment, as standing stocks of coal are heavy. The patent fuel trade is also rather dull, but the demand for coke is fairly steady. Pitwood displays no alteration. The inquiry for prompt supplies is by no means active, and prices remain about 28s. to 28s. 6d. nominally.

LAUNCHES AND TRIAL TRIPS.

SELJE, steamship; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of A/S. Rederiet Odfjell. Engines, triple-expansion surface condensing; constructed by the builders; trial trip, April 11th.

FJORDHEIM, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Nils Rogenaes; dimensions, 384ft. by 51½ft. by 26ft. Engines, Bauer Wach system triple-expansion; constructed by North-Eastern Marine Engineering Company, Ltd.; launch, April 14th.

UNIVERSITY OF LONDON: ADVANCED LECTURES IN PHYSICS.—A course of three lectures on "Les Nouvelles Conceptions Physiques Introduites par le Développement de la Mécanique Ondulatoire" will be given in the Physics Department of the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7, by M. le Professeur Louis de Broglie, Professor of Physics in the Institut Henri Poincaré, Paris, at 5.30 p.m., on Tuesday, Wednesday and Thursday, May 6th, 7th and 8th, 1930. At the first lecture the chair will be taken by Professor A. Fowler, A.R.C.S., F.R.A.S., F.R.S., Professor of Astrophysics and Yarrow Research Professor in the Imperial College of Science. The lectures, which will be delivered in French, are addressed to students of the University and to others interested in the subject. Admission will be free, without ticket.

BRITISH COMPRESSED AIR SOCIETY.—A British Compressed Air Society has been formed to promote and develop the interests of British air compressor, pneumatic tool and pneumatic appliance manufacturers, and to consider all questions connected therewith, except the relationship between employers and employees. We are informed that most of the leading manufacturers in the industry are members, and have got together for the purpose of making a united effort to get this class of British machinery more extensively used. It is the aim of the Society to do a considerable amount of educational work for the industry, as the uses of compressed air are extending greatly. The members are confident that there is great scope for their activities and they hope to assist other industries to realise the benefits arising from the use of compressed air, as well as to aid them in using it most economically. It is the intention of the Society to produce a regular bulletin, and eventually to become the recognised authority on all questions relating to the use of compressed air. The Chairman is Mr. Ernest C. Dunkerton, M.I. Mech. E. (Robey and Co., Ltd., Lincoln); the Vice-chairman, Mr. R. L. Quertier, B.Sc., A.M. Inst. C.E., M.I. Mech. E. (Reavell and Co., Ltd., Ipswich); and the Hon. Secretary and Treasurer, Mr. A. Vincent Clarke, A.M. Inst. C.E., M.I. Mech. E., A.M.I.E.E. (the Hamworthy Engineering Company, Ltd., Poole). The offices of the Society are at 76, Victoria-street, London, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 21/–
(1) Spanish	21/6 to 23/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 10 0	3 10 0
Silicious Iron	3 10 0	3 10 0
No. 3 G.M.B.	3 7 6	3 7 6
No. 4 Foundry	3 6 6	3 6 6
No. 4 Forge	3 6 0	3 6 0
Mottled	3 5 6	3 5 6
White	3 5 6	3 5 6
Midlands—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	— *	—
„ „ Foundry	— *	—
(3) Northampton		
Foundry No. 3	— *	—
Forge	— *	—
(1) Derbyshire—		
No. 3 Foundry	— *	—
Forge	— *	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*) / 4 11 6 (*b*) / 4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 2 6 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	163 12 6
„ (three months)	165 12 6
Copper (cash)	69 5 0
„ (three months)	67 5 0
Spanish Lead (cash)	18 5 0
„ „ (three months)	18 8 9
Spelter (cash)	18 6 3
„ (three months)	18 18 9
Manchester—	
Copper, Best Selected Ingots	61 10 0
„ Electrolytic	66 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 0 11½
„ Condenser, lb.	0 1 0½
Lead, English	19 10 0
„ Foreign	17 17 6
Spelter	18 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/1 per lb.	
Ferro Tungsten	2/10 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£40 0 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	14/–
„ „ Splint	16/– to 17/–
„ „ Trebles	12/–
„ „ Doubles	11/6
„ „ Singles	10/9
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	17/–
„ „ Trebles	12/6
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	10/3 to 12/9
Screened Navigation	16/6
Trebles	12/– to 12/6
Doubles	11/–
Singles	10/9
Lothians—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	12/–
Trebles	11/–
Doubles	10/9
Singles	10/9

ENGLAND.

	Inland.	Export.
(8) N.W. Coast—		
Steams		21/6 to 23/–
Household		38/– to 51/–
Coke		22/– to 22/6
Northumberland—		
Best Steams		13/9
Second Steams		13/–
Steam Smalls		10/– to 10/6
Unscreened		13/–
Household		25/– to 37/–
Durham—		
Best Gas		16/–
Second		13/9 to 14/3
Household		25/– to 37/–
Foundry Coke		26/– to 29/–
Sheffield—		
Best Hand-picked Branch	26/6 to 28/–	—
Derbyshire Best Bright House	21/– to 23/–	—
Best House Coal	20/6 to 21/6	—
Screened House Coal	18/6 to 20/–	—
„ „ Nuts	16/6 to 18/–	—
Yorkshire Hards	15/6 to 17/–	—
Derbyshire Hards	15/6 to 17/–	—
Rough Slacks	9/– to 10/–	—
Nutty Slacks	7/6 to 8/6	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	17/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b.		19/6 to 20/–

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/3 to 13/9
Ordinary Smalls	12/9 to 13/3
Washed Nuts	17/– to 21/–
No. 3 Rhondda Large	20/6 to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	32/6 to 37/–
Furnace Coke (Export)	25/– to 27/6
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	28/– to 28/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	28/– to 32/–
Red Vein	23/6 to 27/6
Machine-made Cobbles	42/6 to 45/–
Nuts	43/– to 46/–
Beans	25/– to 27/6
Peas	19/6 to 20/–
Breaker Duff	10/– to 10/6
Rubbly Culm	10/9 to 11/6
Steam Coals :	
Large	19/6 to 20/6
Seconds	18/– to 19/6
Smalls	12/6 to 13/6
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. * Under revision at the time of going to press.

French Engineering Notes.

(From our Correspondent in Paris.)

Rolling Stock.

THE railway companies have begun to give out contracts for rolling stock in pursuance of the programme which will cover their requirements during the next five years, and the value of orders recently distributed for locomotives and wagons amounts to 330 million francs. Some of the wagon builders are now provided with work until the end of next year. The Est Railway Company has divided an order for fifty locomotives of the "Mountain" class between the Société Française de Construction Mécanique and the Compagnie de Fives-Lille. Two companies have distributed orders for more than 3000 wagons. Meanwhile efforts are being made to carry through the negotiations for the constitution of the international Cartel of wagon builders which have been held in abeyance for a considerable time, mainly through the claims of Italy to a larger quota; but it is hoped that the meeting which was held in Berlin last week to discuss the matter with the Italian representatives will have cleared the way for an early settlement of the points in dispute. French wagon builders are entirely favourable to the Cartel, which they believe will be definitely constituted shortly.

Duties on Motor Cars.

The new tariff on imported motor cars in place of the *ad valorem* duty of 45 per cent. has been put into operation. This step has been taken in view of the unsatisfactory situation of the automobile industry and as a protection against the threatened wholesale importation of cars from the United States, where it is affirmed that preparations have been made to send a huge surplus of cars to this country. The old system of levying duties was found to be ineffective, because it was difficult to ascertain the real value of the cars, and importers are declared to have found means of evading some of them. While the Government affirms that the new duties on weight are merely an adjustment, and do not represent any heavy additional burden, there is no doubt that they mean a substantial increase in the amount of duty paid on foreign cars. On complete cars, for example, weighing less than 1100 kilos. the duty is 8f. per kilogramme; above 2000 kilos. the duty is 15·5f. per kilogramme. The same duties apply to chassis weighing less than 800 kilos. and more than 1750 kilos. On vans and lorries weighing 1150 kilos. and less the duty is 6·25f. per kilogramme, and above that weight 7f. per kilogramme. Engines without electrical equipment and carburetter weighing 200 kilos. and more pay 10f. per kilogramme and below that weight 8·5f. per kilogramme.

A New Liner.

As part of the programme for reviving the shipbuilding industry and giving world-wide publicity to what French shipbuilders can do, elaborate arrangements were made to celebrate the launching of the "Atlantique" from the Penhoët yard at Saint-Nazaire, and sound films of the ceremony will soon be shown all over Europe and in South America. The Minister of the Merchant Marine declared that nothing would be left undone to enable French shipbuilders to secure a share of the world's trade, alike in construction and repairs. The recommendations of the Conseil National Economique will be carried into effect, and the Government will give the necessary financial aid to shipbuilders to enable them to compete for foreign business. On account of a gale, the "Atlantique" was launched the day after the official ceremony. She has been built for the Compagnie Sud-Atlantique for service between France and Brazil. Having an overall length of 225 m., length between perpendiculars 217·5 m., and width 27·5 m., the new liner will have a displacement of 39,000 tons.

Port Rivalry.

The potash deposits in Alsace are worked by the State with the aid of a Société Commerciale des Potasses d'Alsace, which is making arrangements for the shipment of increasing quantities of that product, and the negotiations carried out are giving rise to serious trouble with Belgium and Holland, to the extent that the rivalry between Antwerp and Rotterdam threatened diplomatic complications. At first a contract whereby warehouses capable of containing all the supplies of potash sent for shipment were to be constructed was entered into with the port of Antwerp. Antwerp was unable to provide warehousing facilities for future increased consignments, and negotiations were therefore entered into with Rotterdam, which is capable of handling all the potash sent through that port. Antwerp feared that it would lose the trade, and pressure was brought to bear upon the French Government, which has decided that, in view of the extension of the potash industry, there will be enough traffic to satisfy both ports. Meanwhile Dunkirk complains that it is being sacrificed. A considerable amount of money was spent upon its equipment in the expectation that the Alsacian traffic would be diverted to the French port, but the railways cannot compete with the Rhine, which carries the potash at less than one-half of the cost by rail. Nevertheless, Dunkirk has not lost hope.

Foreign Contracts.

The financial interests of this country in the new States of Central Europe are benefiting constructive engineering firms who have secured important public works of all kinds. Amongst them is the construction of a suspension bridge over the Save between Belgrade and Zemoun, which is to be undertaken by the Société de Construction des Batignolles. The length of the bridge will be 1500ft. and the width 59ft. The same company is also participating with Schneider and Cie. and the Société Hersent in the construction of the port of Gdynia in Poland.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

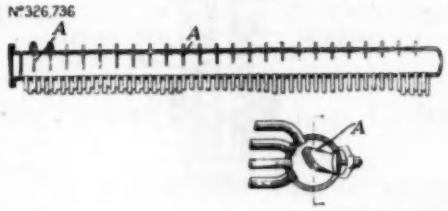
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

326,736. July 9th, 1929.—SUPERHEATER HEADERS, *Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.* 4.

In order to apportion the flow of steam through the tubes of a superheater as evenly as possible, the inventors arrange within the header a series of baffles or diaphragms of gradually increas-

N°326,736



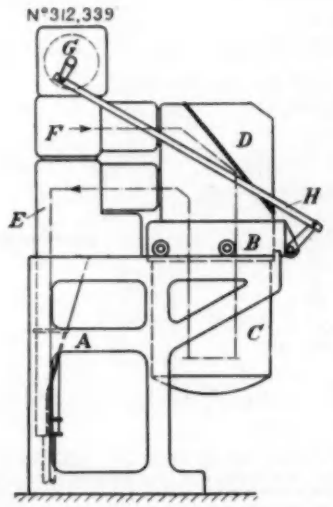
ing size as they are spaced away from the steam inlet. These diaphragms A A are attached to the hand hole covers of the header. In the drawing the steam inlet is on the right.—*March 20th*, 1930.

SWITCHGEAR.

312,339. March 12th, 1929.—SWITCHGEAR APPARATUS FOR ELECTRIC DISTRIBUTING SYSTEM, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to motor-operated carriage switchgear apparatus. The accompanying drawing is a side elevation of a panel of enclosed switchgear with a remote-controlled and carriage-mounted oil switch. A stationary frame A of the switch-

N°312,339

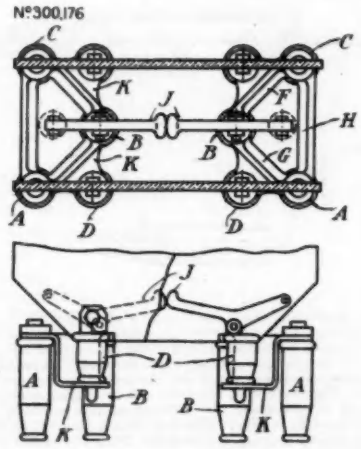


gear supports a carriage-mounted oil switch B with its container C and cover D, a cable connection box E and a bus-bar unit F. The latter supports a switch motor G which operates the oil switch through a link connection H. In switchgear apparatus of this kind space is usually limited horizontally, but it is not so in the vertical direction, and for that reason the arrangement described is particularly advantageous.—*March 13th*, 1930.

300,176. November 2nd, 1928.—HIGH-TENSION ELECTRIC SWITCH, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

With high-tension electric switches with arc-confining barriers

N°300,176

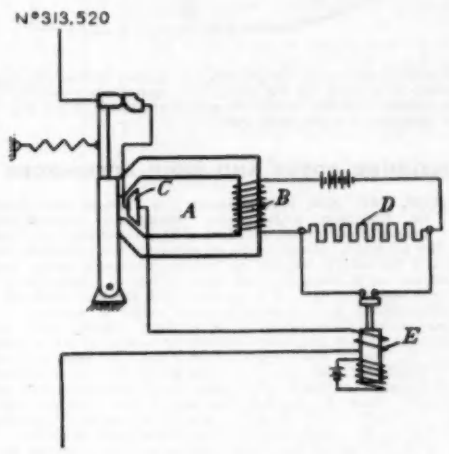


between which the arc is extinguished, surface leakage and undesired discharges, as well as distortion of the arc, have sometimes taken place owing to deposits of metallic vapour on the walls of the barriers, and under certain circumstances these greatly affect the reliability of the switch. According to the invention this defect is obviated. A, B, and C indicate insulating supports, which are held in their respective positions by the three bridge pieces F, G, and H, the rigidity of the whole being greatly increased by this arrangement. The movable switch piece J is carried on the support B. On each of the bridge pieces F and G there is a bracket K, which carry another insulating support D, to which the arc-confining barriers are fixed. It is claimed that a particularly rigid construction of the switch is thus obtained, in which the insulating resistance and the surface leakage path between the arc-confining barriers and the parts of the switch carrying the voltage are considerably increased as compared with other arrangements.—*March 3rd*, 1930.

313,520. June 11th, 1929.—DEVICES FOR PREVENTING THE RELEASE OF POLARISED SWITCHES ON COUNTER-CURRENT, International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.

This specification describes a device for polarised switches which strengthens the energising current of the retaining magnet of the switch on the occurrence of a counter-current. The switch therefore only operates on the occurrence of an excess current flowing in a certain direction. In the accompanying drawing an embodiment of the invention is represented. A is a polarised switch with externally-energised pressure winding B and the releasing winding C. The resistance D is in series with the pressure winding B and in parallel with the terminals of the excess current relay E, the relay reacting only on counter-current.

N°313,520



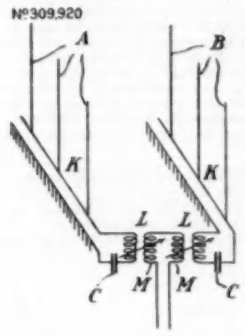
With excess currents of the normal direction the terminals of the relay E remain open and the current energising the retaining magnet has its normal value, determined by the resistance of the pressure winding B and the resistance D. Immediately, however, an excess current of the opposite direction occurs, the relay E closes its contacts. Thereupon the resistance D is short-circuited and the current in the pressure winding B rises to a value determined by the resistance of the latter. The more intensive energisation of the retaining magnet, thus produced, has the effect of holding fast the armature of the retaining magnet, even when the counter-current disappears. The relay E is advantageously so devised that its contacts open again when the counter-current has ceased, so that the energisation of the retaining magnet again returns to its normal value.—*March 13th*, 1930.

TELEGRAPHS AND TELEPHONES.

309,920. April 16th, 1929.—DIRECTIONAL AERIAL SYSTEMS, Telefunken Gesellschaft für drahtlose Telegraphie m.b.H., of 12–13, Hallesches Ufer, Berlin.

This invention relates to directional aerial systems, and more particularly to short-wave systems in which a directional aerial and a reflector are employed. The invention has for its main object to provide a simple and easily operated arrangement in which a good screening action by a reflector is obtained. A is the aerial system and B the reflector system, both systems being constructed in an exactly similar manner and comprising separate wires connected together at the bottom as shown by an energy conductor K, which also connects them with the appropriate tuning circuit constituted by an inductance coil L

N°309,920



and a capacity C. The couplings to the transmitter or receiver, as the case may be, is effected by means of inductive couplings M. The shaded lines in the figure conveniently represent earth connections. The tuning circuits can obviously be associated with the appropriate aerial systems in other ways, for example, through a coupling. Further, instead of employing inductance coils and condensers the tuning circuits can be constituted by extensions of the energy conductor wires, the extensions being of variable lengths, so that the current and potential combinations and the tuning can be varied. The arrangement is said to be very advantageous in practice, since by varying the tuning and phase it is possible to reverse the main current direction, *i.e.*, to treat the transmitting aerial as reflector and the reflector as transmitting aerial.—*March 20th*, 1930.

AERONAUTICS.

326,705. May 9th, 1929.—LANDING GEAR, Boulton and Paul, Ltd., Riverside Works, Norwich, and J. D. North, 4, The Close, Norwich.

This landing skid is made retractable within the body of the aeroplane in order to minimise wind resistance. The skid A is

carried by two pivoted links B B, and by the piston-rods of two pivoted cylinders C C. Within these cylinders there are springs, which normally draw back the pistons and retract the skid, as shown in Fig. 2. When it is desired to land, fluid under

N°326,705

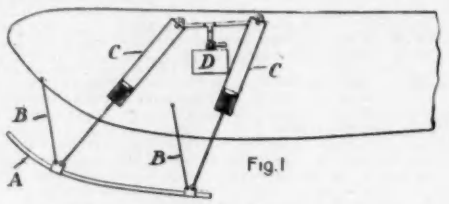


Fig. 1

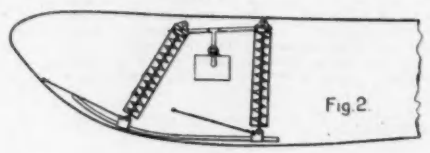


Fig. 2

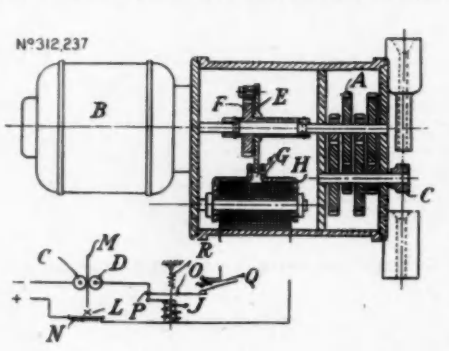
pressure—presumably compressed air—is provided by the compressor D to force out the piston-rods against the resistance of the springs—see Fig. 1—and to absorb the shock of landing by its elasticity.—*March 20th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

312,237. May 21st, 1929.—MEANS FOR FEEDING THE WIRE IN ELECTRIC ARC-WELDING MACHINES, *International General Electric Company, Inc., of* 120, *Broadway, New York.*

The invention relates to an arrangement for regulating the feed of the wire in electric arc welding machines which, even with the use of thick electrode wires, allows of a feed which is certain and is regulated in accordance with the arc. Through a multiple-speed gear A a three-phase motor B transmits its rotary movement to the wire feed roller C, against which the electrode wire is resiliently pressed by means of the counter roller D. On the shaft of the motor B or on the bush coupling this shaft with the gear A a brake disc E is freely mounted, and is coupled with the motor shaft, or, alternatively, with the bush by means of a ratchet wheel device F, so that the brake disc is entrained only when the motor is running in the forward direction. The brake disc E runs between the pole shoes G of the electromagnet H, which, on being energised, tends to hold the brake disc E, whereby a braking effect is exerted. In case of backward running, the brake disc E is not entrained by the

N°312,237

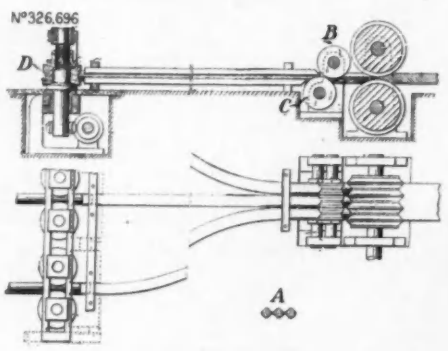


ratchet wheel device F, so that in this direction of rotation the motor is not braked and the ignition of the arc can take place unhindered. The operation of the brake magnet H is under the influence of the arc voltage or current. A voltage coil J is in parallel with the arc L, which is formed between the electrode wire M and the work N. The winding H of the brake magnet is in parallel with the voltage coil J, which has a switch relay armature O mounted on a pivot P for closing the contacts Q. The armature O of the switch is under the influence of the spring R, and the coil J, so that the circuit of the brake magnet is alternately opened and closed in accordance with the arc voltage. The rate of feed of the welding wire, as soon as it becomes too rapid, is reduced by braking until the normal length of the arc is attained. The braking is effected by the production of a strong electromagnet field between the pole shoes G of the electromagnet H. The excitation of the brake magnet may be continuous, either increasing or decreasing according to variation of the current strength with the length of the arc, or may be intermittent, owing to operation of the armature.—*March 20th*, 1930.

326,696. April 25th, 1929.—ROLLING METALS, P. Robinson, Buntsford Hill, Broomsgrove.

The inventor proposes to roll metal bars by first rolling an ingot to a section, such as that shown at A. It is then forced through slitting rolls B and C, which are not positively driven,

N°326,696

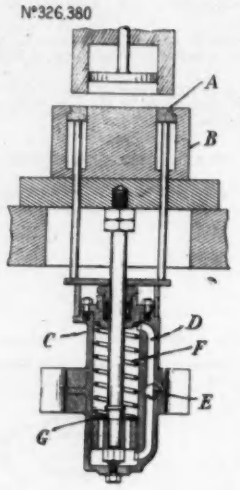


that separate the several sections. Each section is then guided to a set of vertical rolls D, where it is further formed, and may, finally, be passed through a set of finishing rolls. It is claimed that the whole process can be done without reheating.—*March 20th*, 1930.

326,380. April 11th, 1929.—PRESSES, Huntley, Boorne and Stevens, Ltd., and W. L. Brown, Tin Works, Reading.

This press is of the single-acting type. The ring A, in the die B is carried by the rods shown from the cylinder C. This cylinder has a piston on a rod attached to the bed. There is a

N°326,380



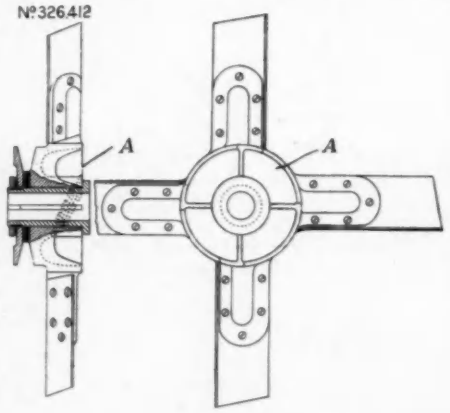
passage D, which may be regulated by the valve E. During the down stroke oil passes from one side of the piston to the other and controls the rate of descent. During the up stroke, which is effected by the spring F, the oil passes freely through holes in the piston and the non-return valve G.—*March 13th*, 1930.

MISCELLANEOUS

326,412. May 21st, 1921.—IMPROVEMENTS IN AND RELATING TO ROTARY FANS, A. Saunders, 21, Second-avenue, Acton Vale, London, W. 3.

From the specification it would appear that the inventor has for his object the use of the area of the boss of a propeller fan for useful service. To this end he provides cavities, as

N°326,412

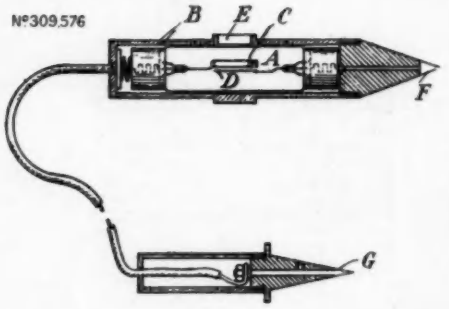


shown at A in the drawing, which are bounded by axial walls, and, it must be assumed, that they are intended to continue the blade impellers towards the centre. There is no explanation in the specification as to how these cavities receive the supply of air which they are supposed to discharge.—*March 13th*, 1930.

309,576. March 13th, 1929.—ELECTRIC VOLTAGE INDICATORS, N. V. Philips' Gloeilampenfabrieken, Emmasingel, North Brabant, The Netherlands.

The invention has for its object to provide an electric voltage indicator of small size adapted to be very easily carried in the pocket and permitting not only of indicating a potential difference with respect to earth, but more particularly the voltage between the poles of a plug contact. A discharge tube A is surrounded by an envelope B of insulating material. The tube

N°309,576

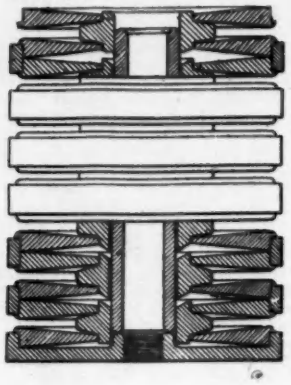


contains an annular electrode C and a plate-shaped electrode D, each secured to a stem through which the connections are taken. The tube is filled with neon under pressure, which enables a glow to be struck between the two electrodes. The caps of the tube contain resistances which are connected to the electrodes, as shown. The interior of the tube can be viewed through the aperture E, the presence of a voltage at the points F and G being indicated by a glow. The indicator is claimed to be suitable for pressures ranging, for example, from 150 to 500 volts.—*March 20th*, 1930.

315,803. July 18th, 1929.—RAILWAY CARRIAGE SPRINGS, *Associated Electrical Industries, Ltd., Bush House, Aldwych, London, W.C.* 2.

The inventors say that this spring is specially suitable for railway vehicles, as it is less bulky than the usual helical spring. It is built up of a series of annular plates, grouped over a central guide. The plates are tapered in cross section and take up the load by flexing in their own plane. The specification includes an

N°315,803



elaborate explanation of the stresses which are set up in the disc, but no formula for the design of the spring is given.—*March 20th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. "The Economical Production and Distribution of Steam in Large Factories," by Mr. F. Carnegie. 6 p.m.

TUESDAY, APRIL 29TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Paper to be submitted for discussion, "The Navigability of the Lower Danube," by Mr. Ebenezer Thomas Ward. 6 p.m.

WEDNESDAY, APRIL 30TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Students' meeting. Annual general meeting of the Association of London Students. 6.30 p.m.

MACHINE TOOL TRADES ASSOCIATION.—King's Hall, Holborn Restaurant, High Holborn, W.C. 1. Annual dinner. 6.45 p.m. for 7.15 p.m.

NEWCOMEN SOCIETY.—Prince Henry's Room, 17, Fleet-street, E.C. 4. "Ancient Civilisations," by Major E. A. Marples. 5.30 p.m.

THURSDAY, MAY 1ST.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—At the Chamber of Commerce, New-street, Birmingham. Annual general meeting. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. The Faraday Medal (ninth award) will be presented to Sir Ernest Rutherford, O.M., F.R.S. The presentation will be followed by the delivery of the twenty-first Kelvin Lecture on "Some Recent Advances in the Electron Theory of Metals," by Mr. R. H. Fowler, F.R.S. 6 p.m.

IRON AND STEEL INSTITUTE.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 p.m. for 7.30 p.m.

THURSDAY AND FRIDAY, MAY 1ST AND 2ND.

IRON AND STEEL INSTITUTE.—At the Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting.

FRIDAY, MAY 2ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Discussion on "Empire Free Trade and the Engineer," to be introduced by Major A. W. Farrer. 7 p.m.

TUESDAY, MAY 6TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. The thirty-sixth James Forrest Lecture on "Aeronautical Progress, 1914 to 1930," by Professor R. V. Southwell, F.R.S. 6 p.m.

WEDNESDAY, MAY 7TH.

INSTITUTE OF METALS.—At the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Twentieth Annual May Lecture, "The Influence of Technique on Research," by Major F. A. Freeth. 8 p.m.

FRIDAY, MAY 9TH.

CHEMICAL ENGINEERING GROUP.—At the Criterion Restaurant, Piccadilly-circus, London, W. 1. 6.45 p.m., annual meeting; 7.30 p.m., annual dinner; morning dress. After the dinner an informal discussion will take place. "The International Abstracting and Classifying of Scientific Literature," introduced by Sir Frederic L. Nathan. The President, Dr. Herbert Levinstein, is expected to speak on "Chemistry House—the Present Position." The General Secretary will deal with "The Jubilee Meeting of the Society."

TUESDAY, MAY 13TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Annual general meeting. 6 p.m.

WEDNESDAY, MAY 14TH.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Whole-day visit to Hope Cement Works.